Final
Design Report

Remedial Action

Subarea 1
Reach A

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Streamside Tailings Operable Unit
Silver Bow Creek/Butte Area NPL Site

Prepared for:
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Mine Waste Cleanup Bureau
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And

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June 1999

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LIST OF ABBREVIATIONS AND ACRONYMS

AA	Assessment Area
AASHTO	Amer. Assoc. of State Highway & Transportation Officials
ABA	Acid-Base Account
ARARs	Applicable or Relevant and Appropriate Requirements
ARCO	Atlantic Richfield Company
BA	Borrow Area
BA&P	Butte, Anaconda, and Pacific Railroad
BMPs	Best Management Practice
bcy	bank cubic yard
cfs	cubic feet per second
$CaCO_3$	Calcium Carbonate
CaO	Calcium Oxide
$Ca(OH)_2$	Calcium Hydroxide
CCE	Calcium Carbonate Equivalent
CEC	Cation Exchange Capacity
CMP	Corrugated Metal Pipe
COE	U.S. Army Corps of Engineers
Comprehensive SAP	Comprehensive Sampling and Analysis Plan
CWA	Clean Water Act
cy	cubic yard
DJ&A	Druyvestein, Johnson, and Anderson
DNRC	Department of Natural Resources
ECCE	Effective Calcium Carbonate Equivalent
EO	Executive Order
EPA	U.S. Environmental Protection Agency
ESD	Explanation of Significant Differences
ft	feet
FDR	Final Design Report
FS	Feasibility Study
HDPE	High Density Polyethylene
I-90/15	Interstate 90/15
ICs	Institutional Controls
IDR	Intermediate Design Report
lbs/A	pounds per acre
lbs/cft	pounds per cubic foot
lbs/ft^2	pounds per square foot
LAO	Lower Area One
LKD	Lime Kiln Dust
mg/Kg	milligrams per kilogram
mg/L	milligrams per liter
MEI	Mussetter Engineering, Inc.
Milwaukee Road	Chicago, Milwaukee, and St. Paul Railroad
MDEQ	Montana Department of Environmental Quality
MUTCD	Manual on Uniform Traffic Control Devices
MWRR	Mine Waste Relocation Repository
NCP	National Contingency Plan

LIST OF ABBREVIATIONS AND ACRONYMS

NPL	National Priority List
NRCS	Natural Resource Conservation Service
NRIS	Natural Resources Information System
NRHP	National Register of Historic Places
OU	Operable Unit
PDR	Preliminary Design Report
PFDR	Preliminary Final Design Report
QA/QC	Quality Assurance/Quality Control
RA	Remedial Action
RI	Remedial Investigation
RD	Remedial Design
ROD	Record of Decision
RRU	Reclamation Research Unit
SAP Addendum	Comprehensive Sampling and Analysis Plan Addendum
SHPO	State Historic Preservation Office
SMP	Shoemaker, McLean, and Pratt lime requirement
STARS	Streambank Tailings and Revegetation Studies
SSTOU	Streamside Tailings Operable Unit
SSWP	Supplemental Studies Work Plan
TIN	triangulated irregular network
UAO	Unilateral Administrative Order
UP-MW	Union Pacific - Montana Western Railroad
VAM	Vesicular-Arbuscular Mycorrhizae

1.0 INTRODUCTION

This Draft Final Design Report (FDR) presents the Remedial Design for Reach A of Subarea 1 of the Streamside Tailings Operable Unit (SSTOU), Silver Bow Creek/Butte (original portion) Area National Priority List (NPL) Site, Silver Bow County, Montana. This report has been prepared for, and at the direction of, the Montana Department of Environmental Quality (MDEQ) and the U.S. Environmental Protection Agency (EPA) to fulfill the requirements of the Unilateral Administrative Order (UAO) (MDEQ and EPA, 1996) and Comprehensive Remedial Design Work Plan (ARCO, 1997a) for the Remedial Design (RD) of the SSTOU. The FDR represents the 100% completion phase of the Remedial Design for Reach A. A Preliminary Final Design Report (PFDR) and FDR of the remaining portion (Reaches B through E) of Subarea 1 will be completed later based upon this design work and field experience.

This report was prepared by the design team as directed by MDEQ and EPA (hereafter referred to as "the Agencies"). The Agencies' design team consists of the following contractors: Maxim Technologies, Inc (Helena, Montana); Inter-Fluve, Inc. (Bozeman, Montana); Mussetter Engineering, Inc. (Fort Collins, Colorado); Montana State University Reclamation Research Unit (Bozeman, Montana); Montana Bureau of Mines and Geology (Butte, Montana); and, Bighorn Environmental (Butte, Montana). A memorandum of agreement between EPA and MDEQ designates MDEQ the lead agency for RD and Remedial Action (RA).

In 1995, the Agencies issued a Record of Decision (ROD) (MDEQ and EPA, November 1995) for the SSTOU. In March 1996, EPA issued a UAO to the Potentially Responsible Party, Atlantic Richfield Company (ARCO) for RD, Remedial Action (RA), and Operation and Maintenance. Under the UAO, ARCO submitted drafts of a Preliminary Design Report (ARCO, 1997b) and an Intermediate Design Report (ARCO, 1997c) for Subarea 1. In April 1997, ARCO refused to do further design work consistent with the Agencies' direction and the Agencies completed the design.

In August 1998, the Agencies issued an Explanation of Significant Differences (ESD), which identifies and selects certain design elements that differ in significant respects from the ROD. Although the differences identified in the ESD are significant for design purposes, none of them fundamentally alters the basic features of the selected remedy. The design presented in this FDR is based upon the ROD, as modified by the ESD.

1.1 PURPOSE

The purpose of this report is to provide the design basis and technical specifications that will be used to construct the Remedial Action for Reach A of Subarea 1. The FDR is a required deliverable as described in the *Final Comprehensive Remedial Design Work Plan, Revision 4* (ARCO, January 1997). To meet the requirements of the Comprehensive Remedial Design Work Plan (p. 95), this report contains the final design report, final engineering drawings, final technical specifications, and a Remedial Action construction schedule for Reach A. Copies of approved forms, permits, applications, waivers, and other documents demonstrating compliance with substantive regulatory requirements for on-site and off-site activities will be compiled at a later date after the Agencies determine the nature of the construction contracting provisions of the project.

The design basis for the Remedial Design embodies the technical and administrative provisions that meet the description of the Remedial Action as detailed in the ROD and as modified by the ESD. The FDR satisfies the Applicable or Relevant and Appropriate Requirements (ARARs) that form the legal basis for the selected remedy. The FDR is the result of an extended design process that began with field work performed by ARCO in 1996 and subsequent design reports (PDR and IDR) submitted by ARCO. Design work by the Agencies builds upon the elements of ARCO's IDR that meet the objectives of the Comprehensive Remedial Design Work Plan. Additional work by the Agencies' design team addresses those areas in the IDR that did not meet

the 60% design required in the IDR and brought all elements of Remedial Design to a 90% completion level in the PFDR. Agency and public comments on the PFDR are incorporated into the FDR.

1.2 SITE DESCRIPTION

The SSTOU is one of several Operable Units that make up the Silver Bow Creek/Butte Area NPL Site. This NPL Site encompasses the historic mining and milling operations within the vicinity of the town of Butte, Montana as well as the mining and milling wastes present in Silver Bow Creek from its headwaters to the terminus of the site where Silver Bow Creek leaves the Warm Springs Ponds system. The SSTOU is defined as Silver Bow Creek, its present stream channel, current and historic floodplain, and railroad beds and embankments adjacent to the floodplain and extends from the downstream end of the Lower Area One (LAO) portion of the Priority Soils Operable Unit to the Warm Springs Ponds, a distance of about 25 miles.

Subarea 1 of the SSTOU is defined in the ROD as that part of Silver Bow Creek and the adjoining fluvially deposited tailings and railroad beds that is located downstream from the western boundary of LAO to the railroad crossing of Silver Bow Creek just downstream of the mouth of Sand Creek. More generally, Subarea 1 begins near the Interstate 90/15 bridge crossing west of Butte and ends near the community of Silver Bow. Reach A of Subarea 1 consists approximately of the upper first mile of the Operable Unit beginning near the I-90/15 bridge and extending downstream to a point near the former Bluebird Mill site (Figure 1.2-1).

In Reach A of Subarea 1, the Silver Bow Creek floodplain is confined to the north by the Butte, Anaconda, and Pacific (BA&P) and Chicago, Milwaukee, and St. Paul (Milwaukee Road) railroad lines. To the south, the floodplain is bordered by the Union Pacific/Montana Western (UP-MW) railroad line. The valley floor in this reach is relatively narrow, generally ranging from 400 to 700 feet wide. Silver Bow Creek flows in a single channel at a base flow discharge of about 20 cubic feet per second (cfs)(ARCO, 1995a). Periodic monitoring of stream flow during the Remedial Investigation (ARCO, 1995a) covering the period from 1984 to 1993 measured a maximum discharge of 116 cfs on May 18, 1991 at surface water station SS-07.

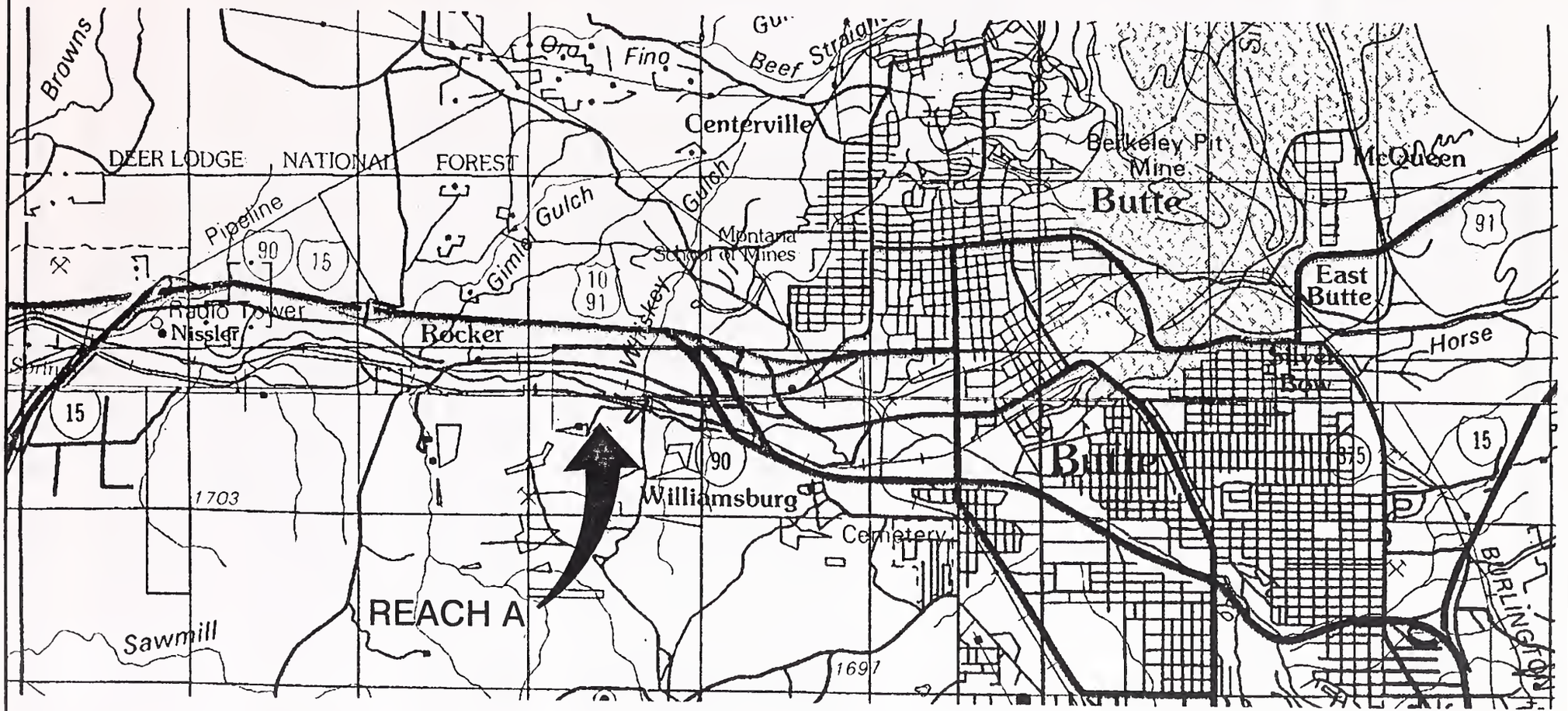
Tributaries to Silver Bow Creek in Reach A are intermittent gulches. The major tributary is Whiskey Gulch which enters Silver Bow Creek from the north, draining a small watershed west of the city of Butte. Almost all of the tributaries flowing from the north collect runoff from mine impacted areas. Tributary input to Silver Bow Creek in Reach A is infrequent and occurs only during precipitation or snowmelt events.

The BA&P railroad, which parallels the floodplain in Reach A on the north side of Silver Bow Creek, is eligible for inclusion in the National Register of Historic Places (NRHP)(GCM, 1992). The old Highway 10 road bed was originally considered as potentially being listed on the NRHP (GCM, 1992) but has since been removed from further consideration and was not included for mitigation in the programmatic agreement for the Regional Historic Preservation Plan (EPA, 1994). The design will not modify the BA&P railroad bed in any material way and avoids effects on this historic resource. Indian cultural and historical resources will be examined further, in coordination with the Salish and Kootenai Confederated Tribe, as well.

There are three road bridge crossings of Silver Bow Creek in Reach A. The two Interstate crossings are elevated well above the creek and are built on piers and large earth fill abutments. The third crossing is a double culvert crossing of the county road between Butte and Rocker at a point just upstream of the confluence with Whiskey Gulch.

Utilities in Reach A include two Butte water lines, the Silver Lake Pipeline, a buried fiber optic telephone line, a sewage sludge pipeline, and aerial phone and power lines. The Butte water lines cross the Operable Unit (OU) over Silver Bow Creek at two aerial crossings between the Interstate bridges. The Silver Lake pipeline is present in the western half of Reach A, running along the northern boundary of the floodplain. A buried fiber

nplsites/ssi/Fig1



N

0 Mile 1

MAXIM 9731701

Location and Vicinity Map
Streamside Tailings Operable Unit
Subarea 1, Reach A
Silver Bow County, Montana
FIGURE 1.2-1

optic telephone line and a sewage sludge line generally run parallel to the old Highway 10. Aerial phone and power lines maintained by Montana Power and U.S. West are present on both the north and south sides of Silver Bow Creek in Reach A, cross the borrow area and the mine waste repository site planned for the Remedial Action, and run parallel to the major county roads and planned haul routes.

1.3 AGENCY DESIGN ACTIVITIES

Subsequent to ARCO's refusal to complete the design as required by the Agencies, MDEQ developed and approved Task Orders with its contractors to complete the PFDR and the FDR for Subarea 1. These task orders were signed at various times during the months of June and July 1997, and July 1998. Major tasks accomplished by the design team prior to actual design were field data collection, stream channel studies, mine waste relocation repository (MWRR) alternative evaluations, railroad materials conceptual design, and pilot testing. These activities are described in the following sections.

1.3.1 Field Data Collection

The Agencies' comments on ARCO's IDR (MDEQ, 1997) identified areas where ARCO had not adequately addressed the data collection requirements of the Comprehensive Remedial Design Work Plan. Supplemental Studies Work Plans (SSWP) and a Sampling and Analysis Plan (SAP) Addendum (Maxim, et. al., 1998) were prepared to guide the collection and analysis of additional data. Additional field work was completed to support Remedial Design decisions for the following areas:

Channel stability analysis: This study was performed to evaluate the existing stability characteristics of Silver Bow Creek in Subarea 1. This information was not collected by ARCO because the IDR assumed that the current Silver Bow Creek stream configuration was stable. The Agencies in their comments to ARCO on the IDR indicated that stream stability analysis was deficient in the design. Thus, the Agency design team undertook this task to fulfill the requirements of the Comprehensive Remedial Design Work Plan and the ROD that the stream be reconstructed as a natural system that is allowed to meander. Study objectives included defining geomorphic characteristics, defining and analyzing hydrologic characteristics, estimating the amount and caliber of upstream and lateral sediment supply under existing and future conditions, analyzing sediment transport dynamics of Silver Bow Creek, and synthesizing this information to provide guidelines for selecting appropriate criteria for the stream-related elements of the remedial design.

Horizontal extent of tailings/impacted soils: The purpose of this investigation was to field verify the horizontal extent of the tailings/impacted soils perimeter as shown in the IDR. The horizontal extent of tailings/impacted soil shown in the IDR was drawn primarily by interpreting the position of the boundary using aerial photography; field verification was required to support the excavation staking plan for the final design.

Additional floodplain backfill: The purpose of this investigation was to refine the evaluations conducted under the Comprehensive SAP prepared by ARCO to characterize additional backfill borrow sites for Subarea 1 which were not previously considered. In addition, excavation of additional soil pits was required in Borrow Area 17 to define the extent of unsuitable materials identified during the initial investigation completed by ARCO in that area.

Streambed sediment sampling: The purpose of this investigation was to collect additional samples from streambed sediments for analysis of arsenic and metals concentrations. This information was used to support the objectives of the *Final Comprehensive Remedial Design Work Plan (ARCO, 1997a)* which specifies that contaminated in-stream sediment will be removed from the stream.

Suspended and bedload sediment samples were previously collected by ARCO but these efforts were focused on collecting fine-grained, loosely consolidated, bedload materials deposited on top of the more permanent streambed. Analysis of these data had not supported the expected correlation between metals contamination and fine-grained material, nor had the study determined the depth of metals contamination. The objective of this addendum was to collect streambed samples from the surface of the more permanent streambed channel to a depth of 10 feet below the streambed surface.

Railroad materials investigation: Remediation of contaminated railroad materials is a requirement of the ROD. Previous investigations of railroad materials were conducted over the entire operable unit and did not provide sufficient detail for design in all cases. This investigation slightly modified the Comprehensive SAP by strictly limiting field activities to Subarea 1 of the Streamside Tailings Operable Unit so that enough information was collected to support an analysis of various design alternatives. As design extends to the other subareas, field data collection will be tailored and focused on the specific alternatives applicable to the railroad materials in each subarea.

Subsurface investigations for mine waste repositories: Mine waste relocation repositories (MWRR) are required by the ROD for disposal of mine waste from the SSTOU. The purpose of this investigation was to obtain geotechnical and hydrogeologic data for evaluating and designing the MWRR. Under the Comprehensive SAP, ARCO did not collect any subsurface geotechnical engineering data to permit evaluation of the stability of the MWRR.

Borrow area soil in-place densities, sediment basin moisture-density testing, and soil sampling: Replacement fill was contemplated in the ROD for reclamation of the floodplain and sediment basins are necessary to protect the reconstructed floodplain and channel from offsite contamination sources. At the IDR design phase, ARCO did not intend to determine the amount of backfill needed to the level of precision that the Agency design team required. In order to determine the amount of backfill required and to design appropriately sized borrow areas, it was necessary to know the relation between the in-place density of the borrow material and the density of the material compacted after placement. In addition, data relative to the suitability of materials for haul road construction (bearing capacity) was needed. Finally, data to support final design of sediment basins (optimum soil density and moisture content) was collected under this SAP Addendum.

Piezometer installation and groundwater level monitoring: The determination of groundwater levels is essential to defining the materials required for removal under the ROD, for determining existing wetland acreage, and for predicting final wetland acreage and reclaimed habitats. The Comprehensive SAP included plans for installation of a limited number of piezometers in the floodplain. As the design proceeded under the direction of the Agencies, primary importance was given to obtaining a more detailed characterization of the groundwater regime in Subarea 1. This resulted in installing more than 50 temporary piezometers to measure groundwater levels.

Streambank sampling: The purpose of this investigation was to characterize arsenic and metals concentrations in vegetated streambanks. Streambanks were not previously sampled and analyzed for metals during the remedial investigation, feasibility study, or remedial design activities. In the IDR, ARCO had indicated that existing streambanks, especially the vegetated ones, would remain in place. The ROD required the removal of metals contaminated materials which cannot be reliably immobilized through in-situ Streambank Tailings and Revegetation Study (STARS) treatment. Collection of arsenic and metals concentration data provided the necessary information to support the removal and reconstruction of streambanks as part of the Agency design.

Channel realignment borehole sampling: The Comprehensive Remedial Design Work Plan provides that data will be collected to "identify reaches that have the potential for changing from a stable (equilibrium) to an unstable (aggrading or degrading) under existing and remediated conditions." In their draft *Conceptual Design Report for Silver Bow Creek* (Inter-Fluve, 1997), Inter-Fluve determined that a one mile reach east of Rocker is potentially unstable under existing and remediated conditions. One proposed remedial alternative for this reach that would attain a stable vertical gradient requires a realignment of the stream through the Stull Storage Area near Rocker and the removal of as much as six feet of floodplain material. Much of the material that would be removed under this alternative would derive from elevations below lithologic information currently available in test pit data and boring logs. In order to determine if the excavated material derived from these lower elevations could be reused on-site, samples were collected under this SAP Addendum to characterize this material and determine if it meets the growth medium or general backfill requirements of the work plan.

Field work was conducted by the Agencies' contractors using standard operating procedures detailed in the Clark Fork River Superfund Site Investigations Standard Operating Procedures (ARCO, 1992a), if available, and standard EPA analytical methods, when available, as referenced in the SAP addendum or SSWPs. Field work was initiated after Agency approval of the SSWP and SAP Addendums in June and July 1997 and completed in January 1998. Data were transmitted to the Agencies by way of either technical memoranda or design reports.

1.3.2 Stream Channel Studies

Many of the additional studies performed by the Agencies and their contractors addressed the questions of geomorphic stability, distribution of contamination in the stream bed and banks, and alternative stream channel and floodplain designs. As discussed in the Agencies' comments to the IDR, these aspects of ARCO's design as presented in the IDR were deficient. The studies undertaken by the Agencies concerning streambank remediation are briefly summarized here.

Inter-Fluve, Inc.; a stream reconstruction firm, and Mussetter Engineering, Inc. (MEI), a firm specializing in river hydraulics and geomorphology, were tasked with evaluating the existing stability characteristics of Silver Bow Creek. Objectives of their study included definition of the geomorphic and hydrologic characteristics of Subarea 1, analysis of the hydraulic characteristics of the stream in Subarea 1, estimation of the quantity and caliber of upstream and lateral sediment supplies, and analysis of the sediment-transport dynamics of Silver Bow Creek in Subarea 1. The purpose of the study was to synthesize this information into guidelines for selecting appropriate design criteria for the stream-related elements of the design in Subarea 1.

The Agencies' design contractors undertook a field investigation to help determine geomorphic and sediment transport characteristics of the stream. Hydrologic, hydraulic, and sediment transport analyses contributed other significant findings about the stream in Subarea 1. These results were presented in the *Channel Stability Analysis* report (MEI and Inter-Fluve, 1997). Some of the more significant results found in this report are:

- Convexities in the channel profile caused by manmade controls (e.g. existing bridges) adversely affect sediment-transport and could cause remedial design failures if the controls were to fail;
- The new channel capacity should be between 150 and 200 cfs to establish a functioning channel system; and
- Degradational and aggradational reaches were identified for potential design modification, if feasible.

The *Channel Stability Analysis* report laid the basis for conceptual design. A series of interim reports on guiding concepts, design criteria, and alternatives analysis culminated in a *Conceptual Design Report* for Silver Bow Creek, SSTOU Subarea One, Remedial Channel Design (Inter-Fluve and MEI, 1998). This report developed the basis for design, developed engineering alternatives, and evaluated alternatives for effectiveness and cost. One of the most significant findings of the *Conceptual Design Report* was the possibility of realizing multiple benefits through selective grade adjustments in Subarea One.

The *Conceptual Design Report* was followed by an addendum in January 1998 which presented a regulated flow option for channel construction. In this option, a temporary diversion channel is constructed to route flood flows around the newly constructed channel for the period of time necessary to establish stable streambank and floodplain vegetation. Because the new channel is protected from flood flows, bank construction methods do not have to be as rigorous and overall cost savings can be realized. Although it is not possible to divert the flood flows in this manner in all reaches because of the confined floodplain, the Agencies selected the regulated flow Alternative for Reach A to realize a cost savings.

At the same time Inter-Fluve and MEI were developing the design of the channel, Maxim conducted tests to define the extent of contamination in the near stream environment (Maxim et.al., 1998). Samples collected from vegetated streambanks in September 1997 demonstrated metals levels similar to those in the surrounding floodplain, verifying the need for bank removal (Maxim, 1997a). Another investigation in December 1997 obtained samples below the stream bed by means of a specially adapted drill rig (Maxim et.al., 1998). These samples demonstrated that most in-stream metals contamination occurs in the upper two feet of the stream bed and that deeper materials have markedly lower concentrations of heavy metals and arsenic (Maxim, 1998e). This information justified the decision by the Agencies to remove only the shallower in-stream sediments. The supporting information presented in the references cited in this paragraph are further discussed in the body of the design report (Sections 3.3 and 3.4).

1.3.3. Mine Waste Relocation Repository Alternatives Evaluation

The IDR developed by ARCO (1997c) proposed to dispose of mine waste at a number of near-stream repositories along Subarea 1. The Agencies expressed concerns with this proposal in their comments on the IDR and previous documents. Major concerns were:

- Potential for MWRRs to contaminate groundwater in the near-stream setting;
- Distribution of wastes over large areas; and
- Cost of monitoring and maintaining multiple facilities for waste disposal.

Because of these concerns, MDEQ tasked Maxim with an alternatives analysis for MWRRs. The objective of this evaluation was to determine the benefits and costs of developing MWRRs in different environmental settings with different design elements. Particular emphasis was placed on protectiveness of groundwater in the different alternatives. Eight alternatives were evaluated for implementability, effectiveness, and cost using generalized MWRR scenarios. Major findings of the *Alternatives Analysis for Mine Waste Relocation Repositories* (Maxim, 1998b) were:

- Near-stream settings could be protective of groundwater under proper siting conditions;
- Although design elements such as synthetic caps could increase the protectiveness of the MWRR, adequate protection could be achieved with appropriate soil cover designs; and

- Two or three MWRR could serve Subarea 1 at a reasonable cost with lessened requirements for future monitoring and maintenance.

Based on these findings, the Agencies selected an alternative that incorporated appropriate soil cover design on a minimal number of repositories in a near-stream setting.

1.3.4 Railroad Material Remediation Conceptual Design

The level of design for Railroad Materials in the IDR was largely conceptual and not at the level of a 60% design required by the Comprehensive Remedial Design Work Plan in the IDR. The Agencies' comments on the IDR stated that the PFDR must include mapping of contaminant areas, sampling as proposed in the Supplemental Studies Work Plan for Railroad Materials, surveying of cross-sections for embankments and abutments, and development of location specific designs for direct contact areas and impacts to floodplain areas. In order to meet these requirements and because remediation of contaminated railroad materials affecting Silver Bow Creek requires cooperation of the railroads' owners, MDEQ directed Maxim to prepare a conceptual design report to present proposed remedial activities affecting the railroads' property. The emphasis of the *Conceptual Design Report, Remediation of Contaminated Railroad Materials* (Maxim, 1998d) was to describe proposed remedies for mitigation of contaminated material affecting Silver Bow Creek by direct contact or through impacts on the floodplain. A special concern in the direct contact scenario was the necessity of affecting embankments and bridges during remediation. The draft report was presented to Rarus Railway and Montana-Western Railway in December 1997 for review and comment by their engineers. Although formal comments have not been received to date, design of Reach A has proceeded because there are no direct contact railroad structures in that reach. Reach A railroad remediation activities are limited to areas having the potential for impacting the floodplain by transport of contaminated sediment through runoff erosion.

1.3.5 Pilot Test

The purpose of the Pilot Test was to test construction and implementation of proposed concepts for stream bank construction, in-stream sediment removal, and construction dewatering methods. MDEQ tasked Inter-Fluve and Maxim with conducting a pilot test to demonstrate particular components of the design for the SSTOU. Four main components were laid out in the *Pilot Test for Channel Construction and Dewatering Final Design Report* (Maxim and Inter-Fluve, 1997):

1. Dewatering of the floodplain tailings/impacted soils with trenches;

2. Dewatering the stream channel by diverting the stream flow;

3. Removing in-stream sediment with suction dredges; and

4. Constructing a section of new stream channel and streambanks.

The pilot test was conducted over a period beginning in late October and ending in early December. Olympus Environmental was the construction contractor. About 450 feet of channel was reconstructed in a new location using a variety of bank construction methods. Monitoring was conducted to document the effectiveness and cost of various components of the design. General conclusions of the pilot test, as described in the *Pilot Test Construction Monitoring Report* (Maxim and Inter-Fluve, 1998) were:

- Trench dewatering was necessary to facilitate tailings removal and channel construction although fine-grained materials were not satisfactorily dewatered;

- Although the flexible tube used to divert the stream proved problematic, stream diversion is the preferred method of dewatering the stream channel;

- Suction dredging of in-stream sediments proved infeasible because of the inability of the dredges to handle rocky materials; and

- A variety of stream bank designs were successfully constructed, allowing a comparison of the construction costs of the different designs.

Information gained through the pilot test design has been employed in the design components used for Subarea 1 Remedial Design.

1.3.6 Material Procurement and Utility Relocation

During the fall and winter of 1998/1999, MDEQ initiated activities to procure most of the rock and lime materials needed for Reach A construction. Several different types of rock were procured and are presently stockpiled in an area just west of the MWRR 2 site. The lime is being stored in a trench on the northern portion of the MWRR 2 site. To prevent degradation of the lime, it will be covered with tarps until construction activities commence.

Overhead power lines and poles in the areas of MWRR 2 and Borrow Area 10 are in the process of being relocated by Montana Power Company. This work will be accomplished prior to Reach A RA construction.

1.4 REPORT ORGANIZATION

This report constitutes Volume I of a two volume set. Volume I contains the design report, references, special provisions and technical specifications relative to construction of the remedy in Reach A, and the design Plan Sheets. The Special Provisions and Technical Specifications are contained in Appendix A. Volume II contains Appendices B through L which present design calculations, supporting data, and other pertinent information relevant to the Remedial Design for Reach A.

The Agencies' design is partitioned into numerous design elements and components. This FDR provides a general summary of the selected design, organized and described for each design element, in Section 2.0. A detailed description of the design is presented in Section 3.0, enumerating objectives, design criteria, supporting data, and design components for each design element. Section 4.0 contains a brief description of ancillary plans which have been and will be completed for Reach A. The Remedial Action Construction Schedule is presented in Section 5.0. Section 6.0 lists the references cited in the report.

Figures and tables have been incorporated with the referencing text in this report. In Volume II, several appendices are notable: Appendix E contains the transportation plan for Reach A construction; Appendix L contains an erosion control plan for Subarea 1 construction; information on lime quality and lime requirement for tailings/impacted soils is presented in Appendix G; and the complete revegetation plan and guiding concepts for revegetation are presented in Appendix J.

2.0 SUMMARY OF SELECTED DESIGN

This section briefly describes the selected remedial design that will be implemented in Reach A of Subarea 1. Each subsection summarizes a specific element of the design. A complete description of design elements and components is presented in Section 3.0 of this report.

This design is intended to fulfill the requirements of the ROD (MDEQ and EPA, 1995) to provide a Remedial Action that will protect human health and the environment and comply with applicable or relevant and appropriate legal requirements (ARARs) for this reach of Silver Bow Creek. It accomplishes this by removing or treating sources of contamination which affect soils, surface water, groundwater, and in-stream sediments in Reach A. Major elements of the design are:

- Excavation of floodplain tailings/impacted soils and in-stream sediments and removal to an engineered Mine Waste Relocation Repository (MWRR);
- Treatment of removed mine wastes in the MWRR with lime amendments;
- In-situ capping of contaminated railroad materials to reduce sediment impacts to the floodplain; and
- Reconstruction of a functioning stream channel and floodplain.

The accomplishment of these actions requires coordination of a number of activities within limitations dictated by the nature of the contaminants in the floodplain. These often interrelated components of the selected design are described in the remainder of this section. The various design components have been organized into the following categories for purposes of description:

- Groundwater dewatering;
- Stream diversion and dewatering;
- Tailings/impacted soil removal;
- In-stream sediments removal;
- Haul route construction;
- Mine waste relocation repositories (MWRR);
- Lime resources;
- Channel and streambanks reconstruction;
- Bridges/stream crossings;
- Borrow area;
- Floodplain reconstruction;
- Mitigation wetlands;
- Revegetation; and
- Railroad materials remediation.

2.1 GROUNDWATER DEWATERING

In Reach A, a significant portion of the tailings/impacted soils are saturated by groundwater. To mitigate problems associated with excavation, transport, and disposal of saturated materials, the groundwater level in the floodplain will be lowered with groundwater dewatering trenches. Important facets of trench dewatering are excavation, pumping, and sediment detention.

Dewatering saturated tailings/impacted materials prior to excavation was selected as the preferred method of preparing these materials for excavation because of the difficulties involved with keeping clean and

contaminated materials from mixing in a saturated environment when the materials are excavated. In addition, wet tailings would otherwise have to be stockpiled and allowed to drain prior to hauling which would require double handling during construction. The locations and depths of the dewatering trenches were based on criteria developed in the *Pilot Test Construction Monitoring Report* (Maxim and Inter-Fluve, 1998).

2.2 STREAM DIVERSION AND DEWATERING

Dewatering of the stream channel was selected as the preferred method for removal of contaminated in-stream sediments and for reconstruction of the channel and banks. Stream diversion and dewatering will also serve the purpose of reducing sediments generated during construction of the channel and will enable construction in an environment relatively free of water. The latter condition is essential for proper installation of materials during channel and bank reconstruction.

Dewatering of the channel for reconstruction includes two components. The first is a diversion system that isolates the construction zone from Silver Bow Creek flow. In the confined upstream section of Reach A (downstream of LAO to below the eastbound I-90/15 bridge), a coffer system will contain stream flow on one side of the channel while the other side is excavated and reconstructed. After one side of the channel is complete, the same coffer system will allow the opposite side to be dewatered by shifting the diversion at the head of the coffer system.

To provide a functioning reconstructed stream system at minimum cost, the design requires that flood flows from Silver Bow Creek be diverted around the reconstructed channel for some period of time while the newly constructed streambanks revegetate. After the streambanks revegetate and can withstand flood flows, this temporary diversion channel will be reclaimed and the entire flow of Silver Bow Creek will be directed to the new channel. The temporary diversion channel will be constructed to contain all Silver Bow Creek flow downstream of the Interstate bridges during the Remedial Action. A detailed reclamation plan for the temporary diversion channel will be provided at a later time in the remedial action process. The major components of the diversion channel reclamation that will be developed in the reclamation plan will include draining the channel, backfilling the channel with stockpiled fill, regrading to conform with the surrounding topography, and revegetation.

The second dewatering component includes dewatering systems that remove incidental water from the construction zone during the diversion channel and stream channel construction. Incidental dewatering will be necessary to collect and remove water within the construction area that originates from seepage and precipitation, as well as other sources. This water will be collected in trenches and sumps and pumped to sediment detention ponds or dewatering trenches constructed for groundwater dewatering described in Section 2.1.

2.3 TAILINGS/IMPACTED SOILS REMOVAL

Tailings/impacted soils constitute the largest source of contamination in the SSTOU. The ROD describes the main design element for remediation of the tailings as follows: "A critical element of the remedy selection is the determination of which tailings may be left in place and which tailings must be removed from the floodplain before being treated with STARS. ... The criteria for determining that specific tailings/impacted soils may be STARS treated in-situ in the floodplain are: 1) The tailings/impacted soils involved cannot be saturated in groundwater during any part of the year. ... 2) STARS treatment must effectively immobilize the contaminants in the tailings/impacted soils. ... 3) The tailings/impacted soils cannot be located where they may be eroded and re-entrained into the stream system through normal stream processes or major flood events." (MDEQ and EPA, 1995, pp. 93-94).

Although in-situ remediation of these materials will occur in some portions of the OU, there were no locations of tailings/impacted soils in Subarea 1 that could meet all three criteria quoted above for in-situ treatment. According to data in the RI, the volume of tailings/impacted soil within 2 feet of groundwater (the expected maximum fluctuation) was about 67 percent of the total volume. Based on more detailed information collected during the design, at least 64 percent of the area of tailings/impacted soils in Reach A of Subarea 1 is saturated or potentially saturated by groundwater during any part of the year (See Section 3.3.4). According to the ROD, the confined nature of the floodplain in Subarea 1 dictates that tailings/impacted soils be removed from the floodplain. These wastes will be treated and placed in a repository located outside the floodplain.

Definition of tailings/impacted soils was accomplished through an extensive test pit investigation in 1996 and 1997 conducted by ARCO with Agencies' oversight (ARCO, 1997c). The horizontal and vertical extent of contamination was found through application of "order-of-magnitude break" criteria to the soils metals data collected from these test pits. The "order-of-magnitude break" was established in the ROD as the means of determining the bottom of tailings/impacted soils for the purposes of removal. Because of variability in the elevation of the base of tailings, an over-excavation factor was applied to provide 95% confidence that 90% of contaminated materials will be removed. Over-excavation is calculated to be about 0.5 feet. The total volume of tailings/impacted soil removal for Reach A is estimated at 174,000 bank cubic yards and the average removal depth is about 2.8 feet. The horizontal extent of tailings is about 36.8 acres in Reach A, excluding the stream channel.

Removal of tailings/impacted soils will occur after the floodplain has been sufficiently dewatered to permit transport of tailings to the repository with minimal spillage. Some areas (e.g., where the diversion channel and haul road lie in contaminated areas) will require removal before tailings/impacted soils can be dewatered. These materials may be left in the floodplain to drain and transported at a later date.

Removal of tailings/impacted soils will be verified through a QA/QC sampling plan which will determine if 90% of the tailings are being removed with 95% confidence. If verification sampling indicates that this criterion is not being met over substantial areas, the over-excavation depth may be increased in as-yet unexcavated areas. However, it is not intended that previously excavated areas will be re-excavated if the criterion is not met. This approach will allow the contractor to excavate to the elevations shown on the plans and conduct his operation without costly delays and interruptions of the construction sequence.

2.4 IN-STREAM SEDIMENTS REMOVAL

The objective for in-stream sediment removal is to reduce direct contamination of Silver Bow Creek by metals-laden sediment. This is a more direct pathway for contamination of Silver Bow Creek than the pathways originating with floodplain tailings/impacted soils contamination, and the ROD recognizes the distinction through differing removal criteria. The ROD criterion for in-stream sediment removal is the removal of fine grained (< 1 mm) sediments in depositional environments. Studies undertaken by ARCO (1997c) did not find the expected relation between fine grained material and higher metals concentrations in streambed deposits on which this ROD criterion was based. Additional information developed by the agencies' contractors (Maxim, 1997a) showed that in-stream metals contamination, although distributed throughout differing depositional forms, was confined to relatively shallow depths. This information was combined with a change in construction methods to develop a new in-stream sediment removal criterion. Because the complete reconstruction of the channel, including bed materials, is part of the agency design, in-stream sediment removal will be necessitated by channel reconstruction and these sediments will be replaced with clean material. Thus, removal of in-stream sediment will occur through reconstruction of the channel, and the goal of reducing direct contact between contaminated in-stream sediment and Silver Bow Creek will be accomplished.

Because the new channel will not follow the existing creek alignment in much of Reach A, much of the existing stream channel will be abandoned and these sediments will no longer directly interact with Silver Bow Creek. In these areas, removal of former in-stream sediments will be dictated by the order-of-magnitude criteria as part of the floodplain tailings/impacted soils removal. Inspection of the in-stream metals data collected by ARCO (1997c) and Maxim (1997a) indicates that almost none of this material meets the order-of-magnitude break criteria for removal from the floodplain. Therefore, in-stream sediments will only be removed and taken to a MWRR where the new channel overlays the old channel and channel reconstruction mandates the removal of the sediments.

For the uppermost portion of Reach A between the interstate bridges, the stream channel will not be relocated but the channel bed and banks will be rebuilt with clean material. In-stream sediments removed in this process will be transported to the MWRR. It is estimated that 1,100 cubic yards of in-stream sediments will be removed from this reach of stream and hauled to the MWRR.

In the remainder of Reach A, in-stream sediments, located in areas where the new channel overlays the existing stream channel, will be removed and clean channel bed material will be placed during channel reconstruction. An estimated 1,200 cubic yards of in-stream sediments will be excavated and hauled to the MWRR from this portion of Reach A. The portions of the existing channel that remain in the reconstructed floodplain will be abandoned and backfilled according to the floodplain reconstruction staking plan.

2.5 CONSTRUCTION HAUL ROUTES

Haul routes will be established to facilitate movement of mine waste materials and borrow material. Development of haul routes minimizes use of public roads and associated safety concerns, and allows use of larger, more efficient haul trucks. Construction haul roads for the remedial action for Reach A have been designed to haul materials efficiently and safely. Because the major borrow source for Remedial Action in Reach A is west of Rocker, a major haul route is planned from Reach A through Reaches B and C to this borrow source. This route requires crossing Silver Bow Creek in two places and crossing the county road east of Rocker. Tailings/impacted soils will be removed at these two floodplain crossings before construction of the haul road in these areas.

Secondary haul roads will also be required with the specific location and design left up to the construction contractor. During construction activities related to the Reach A Remedial Action, haul roads and crossings (public road, stream, railroad, utility) will be maintained and traffic control will be instituted to sustain safe traffic flow.

2.6 MINE WASTE RELOCATION REPOSITORY

Mine waste relocation repositories (MWRR) are a central component of the remedial action. These repositories are intended to provide permanent locations for mine waste that are protective of human health and the environment. One repository location has been planned for Reach A in a near-stream location identified as MWRR 2. This MWRR was identified by ARCO in the IDR. This location will be the repository for all tailings/impacted soils, in-stream sediments, and railroad materials generated by removal activities in Reach A.

An *Alternatives Analysis for Mine Waste Relocation Repositories* (Maxim, 1998b) was prepared for MDEQ and EPA to investigate the effectiveness and cost of alternative MWRR locations and designs. Particular emphasis was placed on protectiveness of groundwater in this investigation. As a result of this information, the Agencies selected an alternative that included near-stream repositories with an appropriate soil cover design. MWRR 2 was selected and designed in accordance with this decision. MWRR 2 has been designed

so that mine wastes can be placed to a total height of about 25 feet in a seven acre area. All mine wastes placed in the repository will be amended with lime. The cover design incorporates local, stripped topsoil and imported, suitable soil to provide a vegetative growth medium. The soil cover and vegetation are planned to reduce the infiltration of water into the repository to less than 0.6 inches of moisture in an average year. This low infiltration rate will reduce the likelihood of leachate generation in the repository.

2.7 LIME RESOURCES

The ROD stipulates that tailings/impacted soils removed to MWRRs will be amended with Streambank Tailings and Revegetation Study (STARS) technology, which in this case means the addition of lime amendments to neutralize the active and potential acidity of the materials and reduce the solubility of metals. Impacted stream sediments and railroad materials removed to the MWRR will also be treated with STARS technology.

Lime sources for the remediation of Reach A include cement kiln dust from the Holnam cement plant in Trident, Montana, and lime kiln dust from the Continental Lime plant in Townsend, Montana and the Montana Limestone Company plant near Warner, Montana. Acid-base accounting (ABA) performed on 44 test pits in Reach A were used to determine the appropriate lime requirements of tailings/impacted soils. Using a conservative approach, the Agency design team selected a master lime rate that accounted for acid generation in approximately 86% of the removed tailings/impacted soil material. For the remaining 14% of the tailings, specific lime rates will be applied to six individual areas of tailings that require higher lime rates. Use of a master lime rate for the majority of the material reduces the need to track specific floodplain materials and lime them at varying rates, thereby simplifying construction management.

The total lime requirement for Reach A tailings/impacted soils and in-stream sediments is 9,400 tons of effective calcium carbonate equivalent (ECCE). This tonnage includes the amount of lime needed to amend tailings/impacted soils removed from haul road areas outside of Reach A. Because some of the available lime sources have significant large particle fractions and moisture, the actual tonnage of lime materials required to be brought to the site will be greater than 9,400 tons. These calculations include the lime requirement for incidental amounts of tailings/impacted soils that originate from haul road construction in Reaches B and C.

2.8 CHANNEL AND STREAMBANKS RECONSTRUCTION

The streambanks in Reach A contain tailings/impacted soils which must be removed to meet the requirements of the ROD. Streambank samples taken by the Agencies confirm that streambank materials contain levels of metals comparable to adjacent floodplain tailings (Maxim, 1997a). To effectively remove tailings/impacted soils from the channel bed and banks, the remedial action for Reach A of Subarea One involves complete reconstruction of the channel for its entire length below the eastbound I-90/15 Interstate bridge. In the upper section between LAO and the eastbound I-90/15 bridge, the channel will be reconstructed to its existing topography, grade, planform and cross-sectional dimensions. This upper reach is not being completely reconstructed because it is confined by infrastructure which does not allow for reconfiguration of the existing channel alignment.

Part of the design process for the Streamside Tailings Operable Unit involved a field demonstration of techniques in the Pilot Test that could be included in the final design. During this aspect of design, the agencies recognized the high cost associated with the stream bank treatments that were engineered to withstand a 50 year recurrence interval flood. An alternative, more cost efficient, approach to stream channel design was adopted that also provides a lower risk of failure. The stream channel design presented in this FDR relies on a temporary diversion system that will be kept in place until an extensive vegetative root system has developed adequately to stabilize the stream banks. It is uncertain at this time how long it will take the grasses and shrubs to develop a sufficiently dense root mass to allow natural stream flows to be released into

the reclaimed channel. As design concepts are refined in this regard, and a procedure is developed to monitor the adequacy of the root system to retard stream migration, updated information will be provided to the public.

The reconstructed channel accommodates the diversion channel and approximates existing planform and grade characteristics, but also includes modifications that provide sediment continuity and geomorphic stability. Below the interstate bridges, the channel cross-sectional area will accommodate design bankfull flows. Channel design is integrated with floodplain design to promote natural geomorphic processes and to establish an interface between aquatic and terrestrial environments.

The Comprehensive Remedial Design Work Plan specifies that bank reconstruction should "emphasize a natural stream system that is allowed to meander" except "in proximity to infrastructure". Two types of reconstructed streambanks are proposed for Subreach A. Between the LAO boundary and the eastbound Interstate (I-90/15) bridge, a non-deformable bank design will be applied. A non-deformable bank is one that is designed to remain in place under all flow conditions up to a maximum design flow. This bank design includes a lower bank foundation, which is immobile and protects against bank failure or migration, and an upper vegetated bank. The non-deformable bank will prevent channel migration that may otherwise affect channel alignment and bridge footings. Immediately upstream and downstream of the existing double culvert bridge in the middle of Reach A , riprapped banks will be incorporated. This isolated section does not include a vegetated upper bank component.

Downstream of the Interstate bridges, deformable channel banks will be constructed. Deformable banks are designed to allow stream migration over time. Long-term stability of deformable banks relies on the strength, cohesiveness, and integrity of the lower bank materials, as well as the establishment of mature vegetation on the upper banks. A reconstructed bank is most susceptible to erosion and failure before mature vegetation becomes established. To address this period of susceptibility, the Agencies have selected an alternative from the *Conceptual Design Report*, Addendum One (Inter-Fluve and MEI, 1998) which relies on a regulated flow in the reconstructed channel for a minimum of three years. Regulated and limited flows in the reconstructed channel allow for a less costly method of bank reconstruction since the banks will not be subjected to the full force of high flows until vegetation is reestablished. Flows will be regulated by a diversion and headgate structure downstream of the Interstate bridges. Storm and runoff flows greater than the regulated flow will be diverted around Reach A in a diversion channel. In the event that the diversion channel capacity is exceeded, excess flows will be routed into the reconstructed channel. This channel will also be used to divert all stream flow from the construction area during construction. The diversion channel component will also allow for Silver Bow Creek flows to be diverted around the remediated channel and floodplain in the event that upstream water quality threatens remediated reaches of Subarea 1.

2.9 BRIDGE/STREAM CROSSINGS

Reach A of Subarea 1 contains five stream crossings: two Interstate bridge crossings; two suspended water pipeline crossings; and one county road crossing. At the upstream end of Reach A, eastbound and westbound I-90/15 bridges cross Silver Bow Creek. These high bridges are supported by piers, several of which are located near the streambanks. Between the bridges are two suspended water pipelines with concrete support structures near the stream banks. Neither the bridge piers nor the water line support structures will be affected by channel or bank design and construction. Areas immediately upstream, downstream, and adjacent to the bridge piers and water line structures will be excluded from remedial channel construction activities. The fifth crossing is a double culvert county road crossing located just west of the I-90/15 eastbound bridge. Due to grade imbalances in the existing channel associated with this crossing and the deteriorating condition of the existing structure, a new culvert crossing is included in the remedial action. The new crossing will be constructed with two culverts. The reconstructed channel will pass through one

culvert. The diversion channel will pass through a second culvert in the right overbank area. This second culvert will remain as an over bank flow culvert after reclamation of the diversion channel.

2.10 BORROW AREA

Floodplain backfill for Reach A and the MWRR 2 cap will require about 85,500 bcy and 15,300 bcy of borrow respectively. The required borrow will be excavated from Borrow Area 10. Based on investigations conducted for the remedial design, an estimated 182,500 bcy of suitable borrow material are available from this borrow area. The suitability of the borrow is based on criteria for physical and chemical characteristics which were identified in the Comprehensive Remedial Design Work Plan. Topsoil from the borrow area will be stockpiled and reused for reclamation of the borrow area.

2.11 FLOODPLAIN RECONSTRUCTION

The Remedial Action for Reach A includes complete reconstruction of the floodplain within the boundaries defined by the horizontal extent of tailings/impacted soils that require removal. In an effort to minimize costs associated with backfill of the remediated floodplain surface and to provide a floodplain topography that is consistent with the goals of the stream channel remediation, floodplain designs consist of a general one percent slope away from the channel to the approximate extent of tailings/impacted soils excavation. This topographic design of the floodplain requires less backfill than reconstruction of the existing topography and, therefore, provides a cost savings over reconstructing existing topography. The margin of the reconstructed floodplain will be tied into the existing topography at the horizontal extent of tailings.

The majority of the reconstructed floodplain surface is a consistent slope both down-valley and from the margins of the floodplain to the channel. Exceptions to this are at the boundary of the excavation surface where existing topography is higher than the remediated floodplain elevation. In such cases, the remediated surface will be blended to the existing topography in 4H:1V slopes. In addition to boundary slopes, overbank terraces and sites for wetland depressions are incorporated in the remediated floodplain. Overbank terraces are located for the purpose of reducing the potential for channel avulsion between meander bends. Terraces have been included at four locations where meander bends have the greatest amplitude. Wetland depressions are located in areas of the floodplain that will not have an impact on channel or overbank hydraulics. Wetland depressions are located largely in association with terraces such that materials excavated from wetland depressions may provide for terrace fill requirements.

2.12 REVEGETATION

Successful revegetation requires two major processes: primary productivity and decomposition. Revegetation planning for the SSTOU focuses on matching plant species to habitats, identifying practices that will establish those species, assuring plant nutrition and nutrient cycling, limiting weed invasion and abundance, and anticipating temporal developments. Revegetation design for Reach A includes substrate treatments, planting prescriptions and practices for revegetation habitat types, and weed control measures.

For each revegetation unit or plant habitat, the Reach A design proposes a revegetation strategy that includes physical treatments, soil amendments, propagule mixtures and techniques, and incorporates competitive and temporal relations. To the extent possible, revegetation strategies will foster diversity, control weeds and erosion, and provide for special values or uses.

2.13 RAILROAD MATERIALS REMEDIATION

Railroad materials are one of the contaminated media identified in the ROD that require treatment or removal. Three classes of contaminated railroad media were identified in the ROD: 1) Contaminated materials that impact the remediated floodplain; 2) Contaminated materials that are in direct contact with Silver Bow Creek; and, 3) Ore concentrate spills. Only materials impacting the remediated floodplain are found in Reach A.

Within and adjacent to Reach A, there are two sources which threaten to impact the remediated floodplain of Silver Bow Creek. The first source is railroad embankments within the SSTOU which are contaminated and which have the potential for eroding arsenic and metals contaminated sediment onto the remediated floodplain. These areas will be remediated by placing a granular/rock cover over the contaminated material to dissipate rainfall and runoff energy and prevent migration of the underlying sediment. At the shoulder of the treated embankments, some contaminated material will be excavated to allow placement of the rock cover flush with the existing grade to maintain positive drainage. The cover material will be placed on top of the bank slope and will key into the remediated floodplain or existing ground at the embankment toe. All drainage channels at the toe of rock-covered embankments will remain.

The second source which threatens the remediated floodplain is contaminated embankments outside of the SSTOU having the same erosional potential as areas within the OU. The Neversweat and Washoe Railroad (formerly the Milwaukee Road which runs along the hillside northeast of Rocker and enters the SSTOU just east of Rocker) has numerous contaminated embankment areas. These areas have been observed to produce eroded arsenic and metals contaminated sediment which eventually migrates to the Silver Bow Creek floodplain. Because these sources are outside the SSTOU, they will not be directly remediated. Instead, five basins have been designed to control runoff from the off-site embankments in the area of Reach A. These sediment basins are designed to retain a specific soil particle size during a 10-year peak discharge. Emergency spillways on each basin will pass flows in excess of the 500-year flood.

3.0 REMEDIAL DESIGN ELEMENTS

This section of the FDR describes in detail each element of the selected design for Reach A of Subarea 1. As in Section 2.0, this section has been organized by major design elements. Within the sections for each design element, the objectives, design criteria, supporting data, and design components are highlighted. Other supporting information is referenced in previously submitted design transmittals to the Agencies, is cited in technical literature, or is present in other referenced documentation. Appendices at the end of the report contain supporting information relative to the selected design for Reach A.

3.1 GROUNDWATER DEWATERING

In Reach A, a significant portion of the tailings/impacted soils are saturated by groundwater. In order to mitigate the problems associated with excavation, transport, and disposal of saturated materials, the groundwater level in the floodplain will be lowered with groundwater dewatering trenches. The locations and depths of the dewatering trenches were based on criteria developed in the Pilot Test Construction Monitoring Report (Maxim and Inter-Fluve, 1998). During the construction of the trenches, the discharge water from the dewatering trenches will be pumped to sediment detention ponds. Results of the Pilot Test showed that sediment from dewatering trenches was produced only during construction of the ditches.

3.1.1 Objectives

The Comprehensive Remedial Design Work Plan states that "general construction methods for implementation of the RA may include: dewatering of saturated tailings/impacted soils, if necessary, by trenching, by placement of the material in dry piles or windrows to drain, by pumping to reduce the ground water table, or with the use of mechanical equipment, as appropriate." The objective of groundwater dewatering is to dewater the saturated tailings/impacted soils prior to removal.

Dewatering saturated tailings/impacted materials prior to excavation was selected as the preferred method because of the difficulty of keeping clean and contaminated materials from mixing when the materials are saturated by groundwater. In addition, wet tailings would otherwise have to be stockpiled and allowed to drain prior to hauling which would require double handling by the construction contractor. Dewatering offers the advantage that excavated tailings/impacted soils will drain in place to the extent that the materials will be more easy to handle and will be lower in moisture content for direct placement in MWRRs.

3.1.2 Design Criteria

Based on construction experience gained from the *Remedial Design Pilot Test* (Maxim and Inter-Fluve, 1998), the following design criteria will serve as guidelines for locating the groundwater dewatering trenches:

1. Locate the centerline of outer trenches within 40 feet of the outer extent of the impacted soils saturated by groundwater.

2. Locate the trenches no further than 150 feet apart centerline to centerline.

3. To provide for optimum groundwater removal, the base elevation of the trenches shall be greater than three feet below the base elevation of tailings/impacted soils saturated by groundwater.

4. Groundwater must be detained for a sufficient amount of time to reduce turbidity prior to release to Silver Bow Creek. Sediment detention ponds shall be sized based on the projected flow in the trenches and guidelines outlined in *Montana Sediment and Erosion Control Manual* (MDEQ, 1996).

3.1.3 Supporting Data

The pilot test was conducted over a period beginning in late October and ending in early December. Two groundwater dewatering trenches and a combination stream diversion/groundwater dewatering trench were constructed to effect dewatering. Monitoring was conducted to document the effectiveness and cost of various components of the design. The design criteria are based on the results and recommendations of the *Pilot Test Construction Monitoring Report* (Maxim and Inter-Fluve, 1998).

3.1.4 Design Components

The groundwater dewatering system consists of two design components: (1) sediment detention ponds designed to capture sediment from the dewatering trenches, and (2) dewatering trenches designed to lower the groundwater in the floodplain.

3.1.4.1 Sediment Detention Ponds

To comply with the guidelines in the *Montana Sediment and Erosion Control Manual* (MDEQ, 1996), the sediment ponds must have a minimum surface area of 140 square feet per 100 feet of dewatering trench (See Appendix B for calculations). The design surface areas, according to MDEQ standards, will settle soil particles 0.02 millimeters (mm) in diameter or larger. The general pond locations, inlets, and outlets are shown on Sheets M6a-M6d. The pond sizes are shown on the detail sheet, Sheet M6e. The construction contractor shall construct the ponds to these sizes at the general locations shown.

The sediment detention ponds shall be constructed prior to the dewatering trenches. Sheet M6e shows a cross section of a typical sediment detention pond. As shown on Sheets M6a-M6d, the ponds will generally be located on the upgradient side of the stream diversion channel, which will be constructed prior to the ponds.

Embankments on the downslope side of the ponds will be constructed from clean local material, and to the extent possible, the upgradient slopes of the ponds may be cut into the existing ground. The depth of the ponds shall be 3.5 feet from the top of the embankment to the bottom of the basin.

The sediment detention pond embankments shall be constructed in 12-inch maximum lifts and compacted to at least 95% of maximum standard Proctor density. The uphill sides of the ponds may use existing terrain for side slopes where feasible. MDEQ (1996) recommends that the length to width aspect ratio should be approximately 6:1. To minimize the size of the sediment ponds, the trenches must be constructed sequentially. After the construction on each trench is completed and the Owner's representative has determined the discharge is visibly free from sediment, the dewatering discharge will be rerouted from the sediment ponds to the stream diversion channel or stream channel. The inlet areas of the sediment detention ponds shall be protected from erosion with filter fabric covered by Type 2 stone. The discharge areas from the ponds into the stream diversion channel or stream channel shall be similarly protected. This erosion protection method was successfully used in the Pilot Test (Maxim and Inter-Fluve, 1998). Reclamation of the sediment ponds will consist of regrading the ponds to pre-existing conditions and revegetating the disturbed areas.

3.1.4.2 Dewatering Trenches

Construction of the dewatering trenches will begin with excavation of the sumps at the downgradient end of the trenches. A typical cross-section of a sump is shown on Sheet M6e. The base of the sumps shall be at least two feet below the grade of the dewatering trench. The sumps will be packed with gravel to filter

sediment. In the section where it will be submersed, the sump riser pipe shall have a minimum of 40 square inches (in^2) open space per 100 feet of trench (See Appendix B for calculations). Therefore, if a 1,000 foot trench is constructed, a minimum of 400 in^2 of open space are required in the section of riser pipe in the sump below the pre-pumping water level. The pumps must have a minimum capacity of 50 gallons per minute per 100 feet of trench. The pump system must operate continuously. In order to meet this requirement, a backup pumping system shall be available onsite consisting of a spare pump and generator or compressor. The maximum length of a single trench shall be 1,000 feet.

The locations of the groundwater dewatering trenches were determined using the design criteria in Section 3.1.2. A typical groundwater dewatering cross-section is shown on Sheet M6e. After the construction of each trench is complete and the pumped discharge is clear, the discharge from that trench will be rerouted to the stream diversion channel or stream channel (in the case of Sediment Pond F (SPF)).

Construction of the dewatering trenches should be completed at least two weeks prior to the initiation of the tailings/impacted soils removal. Groundwater dewatering is most effective when Silver Bow Creek is diverted from its existing location as the lowest point in the floodplain.

The tailings/impacted soils and in-stream sediments excavated from the trenches will be disposed in MWRR 2. Saturated tailings/impacted soils and in-stream sediments must be stockpiled to drain water prior to hauling to MWRR 2. The Owner's representative will determine when these soils are sufficiently dewatered to haul to MWRR 2. Clean material excavated below the tailings/impacted soils will be stockpiled on a clean bench, as shown on Sheet M6e, and will be used for backfill of the trenches.

3.2 STREAM DIVERSION AND DEWATERING

This section details the design for diversion and dewatering of Silver Bow Creek. Stream diversion and dewatering will facilitate removal of contaminated in-stream sediments and reconstruction of the stream channel and streambanks. The measures are designed to be in compliance with the objectives of the ROD and the Comprehensive Remedial Design Work Plan. Designs described in this section are details developed from concepts presented in the *Conceptual Design Report* (Inter-Fluve and MEI, 1998) for all of Subarea 1, and its Addendum One, for Reach A only. The *Conceptual Design Report* describes alternatives for channel remediation and associated dewatering alternatives. The alternative selected by the Agencies is presented in this section. Criteria for abandoning the diversion channel are presented in the vegetative establishment portion of section 3.8.4.3.

3.2.1 Objectives

The Comprehensive Remedial Design Work Plan (p. 69) states that: "RD objectives for in-stream sediments include: removal and treatment of contaminated, fine sediments in depositional areas within Silver Bow Creek." In order to remove these materials efficiently and to address water quality impacts associated with remedial work in or near Silver Bow Creek, dewatering of Silver Bow Creek is necessary. Dewatering of Silver Bow Creek is also necessary to accomplish efficient removal of near-stream tailings/impacted soils and for reconstruction of the channel and streambanks. Reconstruction involves specific backfill placement and protocol which require a construction area free from moving waters. The Comprehensive Remedial Design Work Plan (p. 76) states that relocation of the channel to "facilitate construction dewatering and excavation of the tailings/impacted soils, streambanks and in-stream sediments" will be incorporated where appropriate.

The Remedial Design for Reach A also includes a temporary stream diversion and flow regulation system. Based on evaluation of alternatives presented in the *Conceptual Design Report* (Inter-Fluve and MEI, 1998), MDEQ selected a regulated flow alternative for unconfined sections of Reach A. This regulated flow

alternative is further discussed in Section 3.8. The objective of the diversion system is to limit flows in the reconstructed channel and to provide adequate soil moisture conditions for vegetative establishment, factors that must be considered when relying on bioengineering techniques to reconstruct streambanks. Additional objectives of the diversion system are to provide a means to route Silver Bow Creek around the reconstructed portions of channel and floodplain in the event that upstream water quality threatens remediated reaches of Subarea 1.

3.2.2 Design Criteria

The following design criteria for dewatering and diversion have been developed to meet the objectives of the Comprehensive Remedial Design Work Plan. Derivation and justification of all values and discharges applied in these criteria are discussed in the *Conceptual Design Report* (Inter-Fluve and MEI, 1998) and are not included in this document. For those criteria not previously justified, further explanation is included herein. Where the temporary diversion system is available to convey Silver Bow Creek flows during the excavation and reconstruction period, the diversion channel will serve as the dewatering system. Where no diversion system is available, dewatering will be accomplished with in-stream coffer systems.

Design criteria for temporary diversion and diversion channel are:

1. The diversion channel will be designed to contain up to the 10-year flow (610 cfs) with one foot of freeboard for a minimum of 10 years. The 10-year flow was selected based on the criteria for design flows applied to the diversion channel at LAO.

2. The diversion channel will be designed to withstand the shear stresses generated at its design capacity (610 cfs).

3. At the diversion channel outflow, the reconstructed channel immediately upstream will be armored to withstand the diversion channel design flow (610 cfs) and prevent potential headcutting.

4. The diversion structure will include two culverts with headgates that will allow flows of approximately 50 cfs into the reconstructed channel. The headgates may be closed in order to divert all flows into the diversion channel up to its design capacity (see Section 3.8.2.2 for justification of the 50 cfs design flow for the reconstructed channel).

5. Flows that exceed the capacity of the diversion channel (610 cfs) will access the reconstructed channel.

6. The diversion structure will be designed to withstand a 50-year event. The 50-year flow was selected to provide a significant measure of protection to the diversion system, for the anticipated life of the diversion system, while limiting the cost and horizontal extent of armoring necessary to accommodate overtopping at larger flows.

7. Construction haul road crossings will be designed to withstand diversion channel flows up to 70 cfs. This flow exceeds the maximum recorded mean daily flow of 67 cfs for the anticipated construction season between August and November (Inter-Fluve and MEI, 1998). Further discussion justifying this design discharge is in the Conceptual Design Report (Inter-Fluve and MEI, 1998).

Design criteria for dewatering during removal of contaminants and reconstruction of the channel and streambanks for Reach A of Subarea 1 where no diversion system is possible are as follows:

1. Dewatering will be sufficient to allow for efficient removal of contaminated materials and effective reconstruction of the channel and streambanks.

2. The primary dewatering system will be designed with a minimum capacity of 30 cfs. This flow exceeds the maximum recorded mean monthly flow of 29 cfs for the anticipated construction season between August and November. Daily flows which exceed this value have historically been of extremely short duration.

3. Where the diversion channel cannot be utilized, the dewatering system will be designed to allow storm-generated overflow into the existing channel or undisturbed floodplain surfaces and will incorporate protection to minimize damage to work in progress or entrainment of exposed contaminants.

3.2.3 Supporting Data

All discharge values applied to stated return interval flows were determined through hydrologic analyses conducted as part of, and reported in, the *Channel Stability Analysis* report (MEI and Inter-Fluve, 1997). Design discharges are summarized in the *Conceptual Design Report* (Inter-Fluve and MEI, 1998).

Hydraulic conditions were modeled for the designed diversion system. All HEC-RAS models of design conditions for the diversion structure and channel are presented in Appendix C.

3.2.4 Design Components

There are three primary components to stream diversion and dewatering for Reach A: (1) a temporary diversion system for regulating flows following reconstructed channel construction; (2) dewatering of channel flows during excavation and channel reconstruction activities; and (3) incidental dewatering of seepage flow in construction areas.

3.2.4.1 Diversion and Diversion Channel

Downstream of the Interstate Highway bridges a temporary diversion channel will be constructed as part of a regulated flow system for the reconstructed channel. The diversion will be located downstream of the eastbound Interstate bridge (Sheet I2). The diversion will include a pair of headgates that, when open, will allow flows up to approximately 50 cfs into the reconstructed channel. A 50 cfs regulated flow was selected as that flow which will allow base flow (approximately 20 cfs), and most frequent and short duration high flows, into the reconstructed channel. Based on the flow duration curve developed in the *Channel Stability Analysis* (MEI and Inter-Fluve, 1997), flows are less than the selected flow of 50 cfs 97 percent of the time. Consequently, the reconstructed channel and banks will experience the vast majority of the range of soil moisture conditions available for development of riparian vegetation. Riparian vegetation establishment is crucial for streambank stabilization. When the headgates are closed, all Silver Bow Creek flows will be diverted into the diversion channel. The diversion channel will run parallel to the reconstructed channel and will be located outside of the tailings removal area wherever possible, while still accommodating other project components. When the combined capacity of the diversion culverts and the diversion channel are exceeded, excess flow will be routed over a spillway in the diversion structure and back into the reconstructed channel.

Diversion Headworks

The diversion headworks utilizes culverts, a raised inlet to the diversion channel, and an overflow spillway to provide three stage regulation of flow (Sheet I23). At low flows (up to approximately 35 cfs) all stream flow

will pass through the diversion structure culverts and enter the reconstructed Silver Bow Creek channel. Higher flows (>35 cfs) will begin to access the mouth of the diversion channel, to the point where approximately 550 cfs enters the diversion channel and 97 cfs pass through the diversion structure culverts (Table 3.2-1). At this point the sum of the discharge in the diversion channel (~550 cfs), and that flowing through the culverts (~97 cfs), approximates the 10-year discharge, which is the design discharge for the diversion system. At progressively higher flows, a spillway will return a portion of the flow back to the Silver Bow Creek channel, thus protecting the diversion channel from overload. It is expected that the headworks will regulate flow in this manner up to the 50-year discharge of approximately 1,042 cfs. During flow events that exceed the 50-year discharge diversion channel levees may be topped, in which case water will spill from the diversion channel onto the floodplain.

Table 3.2-1 shows the apportionment of discharges through various components of the diversion system at a range of flows up to the 50-year flow. Due to the complex hydraulics associated with multiple flow paths, the cutoff discharges outlined in the design criteria could not be achieved. The discharges outlined in Table 3.2-1 reflect the best possible apportionment of flows which approximate those specific discharges listed in the design criteria. The most significant deviation from the specified criteria is the discharge that passes into the reconstructed channel. The reconstructed channel is designed for a discharge of 50 cfs. While greater than 50 cfs will flow into the reconstructed channel during 2-year and greater flows, the flow duration for such events is less than 1 hour per year (MEI and Inter-Fluve, 1998). Further, detailed discussion of the diversion system design process and its justification is provided in Appendix C.

TABLE 3.2-1
EXPECTED DISCHARGE APPORTIONMENT AT DIVERSION CHANNEL HEADWORKS
Reach A (Subarea 1) - SSTOU Remedial Design

Total Discharge (cfs)	0-35 cfs	229 cfs (~2-yr flow)	647 cfs (~10-yr flow)	790 cfs (~20-yr flow)	1,042 cfs (~50-yr flow)
Silver Bow Creek channel	35	69	97	103	110
Diversion channel	0	160	550	660	798
Spillway into Silver Bow Creek channel	0	0	0	27	134

Diversion Channel

Below the headworks, the diversion channel is trapezoidal in cross-section with 2H:1V side slopes. The bed width is 6 feet upstream of the pipe-arch culvert (at the county road crossing), and 5 feet downstream of the culvert. The channel slope was designed to optimize cut/fill quantities while incorporating elevation constraints present at the diversion channel inlet, diversion channel outlet, and the pipe-arch culvert. Diversion channel slopes range from 0.12% - 0.49%. The diversion channel embankments (levees) will be constructed of fill material, placed and compacted as per the Specifications, with side slopes of 2H:1V and a top width of 4 feet. An analysis of the structural stability of the proposed embankment is provided in Appendix C (see Sheets I16-I22 for cross-sections).

Diversion channel conveyance is dictated by levee heights and the capacity of the pipe-arch culvert. These factors were initially balanced to produce a diversion channel which conveyed 610 cfs while allowing one foot of freeboard. It was determined through HEC-RAS modeling that this diversion channel configuration would convey 800 cfs (Table 3.2-1) at bank full if levee heights were increased slightly in the reach upstream of the pipe-arch culvert. This adjustment added approximately 0.5 foot to levee heights immediately upstream of the pipe-arch culvert. The height adjustment decreases linearly with distance upstream of the culvert and, at the mouth of the diversion channel, the adjustment was only about 0.1 foot. These adjustments were made, giving the diversion channel a capacity of 610 cfs (10-year discharge) with 1 foot of freeboard, and approximately 800 cfs (the channel's portion of the 50-year discharge) at bankfull.

Diversion Channel Lining

The diversion channel lining will consist of a layer of stone riprap placed 1 foot thick (see Sheet I24 for typical cross-sections and Sheets I16-I22 for specific riprap elevations). The lining will extend to 1 foot above the 610 cfs water surface as determined by HEC-RAS modeling, with the exception of two short reaches discussed below. The top of the channel levees will coincide with the 800 cfs water surface elevation. A flow of 800 cfs is the expected diversion channel discharge during the 50-year event. Table 3.2-2 specifies the two size gradations for the diversion channel lining.

Exceptions to the above-mentioned criteria are: 1) the outside of the sharp bend between Stations D2+00 and D3+00, where an additional 0.5 foot (for a total of 1.5 feet) must be added to account for the calculated super-elevation of the water surface; and 2) the diversion structure embankment, where an additional 0.4 foot was added for the same reason (see Appendix C for super-elevation calculations). At both of these locations, riprap will be installed to the top of the levee.

TABLE 3.2-2
DIVERSION CHANNEL STONE SIZE GRADATIONS
Reach A (Subarea 1) - SSTOU Remedial Design

Size Gradation	% Finer by Weight			
	100%	70-90%	40-60%	0-20%
Type 1 Stone	15"	12"	9"	4"
Type 2 Stone	10"	8"	7"	3"

The gradations shown in Table 3.2-2 were established from calculation of incipient motion particle size based on HEC-RAS output (shear stress). The gradation for Type 2 Stone was determined to be sufficient for diversion channel lining at all locations except immediately upstream and downstream of the grade control structure located just upstream of the diversion channel outfall. Hydraulic conditions in the proximity of the grade control structure require that larger size riprap material be used. The Type 1 Stone gradation was developed for these specific locations (Sheet I24 includes a schedule of lining materials and their locations).

Diversion channel lining stone will be installed directly over the excavated channel or compacted backfill without a layer of filter gravel or filter fabric. The primary purpose of such a filter is to extend the life and function of the riprap. The filter reduces piping of fine materials through the lining and reduces the potential for lining material to sink into saturated subgrade materials. However, following construction, the diversion channel will experience flow less than 3 percent of the time, and then only during short duration high flows.

The diversion channel is designed to be a temporary structure and it will rarely have water flowing in it after construction; therefore, filter material was determined to be unnecessary. The omission of a filter layer from diversion channel lining will result in substantial cost savings by eliminating the material needed for a filter, the installation expenses, and the additional excavation that would be required to accommodate additional liner materials.

Pipe-Arch Culvert

The diversion channel is routed through a pipe-arch culvert at the location of the existing county road crossing (Sheet I26). This culvert was sized to convey a diversion channel discharge of 610 cfs with minimal headwater depth. The prescribed 7'7" x 11'10" structural plate pipe-arch culvert will convey 610 cfs, while maintaining an upstream water surface elevation approximately 0.8 ft above the culvert crown. This size culvert was used in the HEC-RAS model to determine water surface elevations in the diversion channel at flows of 610 cfs and 800 cfs. Additional information on this culvert, and on the identical culvert to be installed in the Silver Bow Creek channel, is presented in Section 3.9 of this document.

Diversion Channel Outflow

The diversion channel will empty into the existing Silver Bow Creek channel at the downstream end of Reach A (Sheet I25). When remedial work on Reach B is conducted, this diversion channel may be extended through Reach B. At the design discharge of the diversion channel (610 cfs), there is potential for significant scour and erosion where the diversion channel empties into the existing Silver Bow Creek channel. Preliminary hydraulic modeling indicated that a hydraulic jump would form downstream of the diversion channel outflow and erosional forces associated with this would result in a scour depth exceeding 3 feet for a distance of approximately 130 feet beyond the diversion channel outflow. The diversion channel outflow at the lower end of Reach A is not expected to be in place for more than one year. Therefore, protection against erosion at this location was limited to a grade control and a heavier riprap lining upstream and downstream of the grade control.

3.2.4.2 Haul Road Crossings

Remedial action will require haul road crossings for construction equipment over the diversion channel. The number and locations of the haul road crossings will be determined by the contractor. Designs for haul road crossings are provided on Sheet I25. Designs for the crossing are further detailed in Appendix C.

Haul road crossings will be placed to span the diversion channel for use during the construction phase of Reach A. The roads will be a maximum of 50 feet wide to accommodate trucks and construction equipment. Two, 3-feet diameter culverts were chosen to provide a minimum conveyance capacity of 70 cfs. This flow will accommodate the maximum recorded daily flow of 67 cfs for the anticipated construction season between August and November (Inter-Fluve and MEI, 1998). Two culverts were chosen in order to fit within the diversion channel and maintain required spacing between the culverts. Using a maximum slope of ~~1.5~~2H:1V for the faces of the road and culvert results in a total culvert length of 72 feet.

Flows in the diversion channel exceeding approximately 100 cfs will overtop the haul roads, potentially causing washout. The required minimum thickness of material to be placed over the culverts is one foot. One foot of cover was calculated using a truck weighing up to 100 tons with three axles. After placement of the road surface material (granular fill), the cover thickness over the culverts will be 2.0 feet which provides a safety factor for excessive load crossings and reduces the distance from the top of the bank to the height of the road. The material to be used for culvert construction is galvanized steel with a gage of 0.064 inches. The diversion channel slope will be maintained through the culverts.

Haul road crossings are temporary features that will remain in place only during construction activities. Crossings will be removed after construction, or when no longer needed, and should not be left in place over winter. If winter shut down is necessary, the crossings will be completely removed, leaving the diversion channel rock lining undamaged. Once construction commences, the crossings are to be re-installed. After the useful life of the haul road crossing is complete, all crossing materials are to be removed by the construction contractor. At these locations the diversion channel must be lined with riprap and any levees must be returned to the correct height as originally specified.

3.2.4.3 Dewatering of the Existing Channel

The second design component is dewatering the existing channel to allow for removal of contaminated in-stream sediments and stream bank tailings/impacted soils and to minimize mine tailings/soils entrainment and downstream transport. Dewatering will also allow for reconstruction of Silver Bow Creek in a relatively dry construction area. Dewatering of Silver Bow Creek flows will be accomplished in one of two ways. The diversion channel will be used as the primary dewatering system for the reconstructed deformable channel, downstream of the Interstate bridges. In the upstream portion of Reach A, from the upstream reach boundary to the diversion structure (Stations 0+00 to 12+00), cofferdams will be used for dewatering.

A cofferdam is an impermeable wall installed in the channel parallel to the banks which confines stream flow to one side of the channel. This requires initial pumping of stream water entrapped behind the cofferdam, and collection and pumping of seepage flow during construction efforts. One side of the channel will have contaminated materials removed while the other is flowing.

Two types of cofferdams were analyzed for potential application. The first was a system of "jersey barriers" (concrete highway barriers) placed in the channel with an impermeable apron draped over them. Jersey barriers were not selected, because they could overturn due to hydrostatic forces unless they were constructed prohibitively heavy and large. Details of this analysis are presented in Appendix C. The preferred cofferdam is a Port-a-Dam™, or similar structure. This dewatering system can effectively contain up to 30 cfs in half of the channel while the other half is dewatered for construction, allowing the stream to flow past construction areas within the channel. A detailed analysis of the effectiveness of this system for dewatering the design flow (30 cfs) is presented in Appendix C.

3.2.4.4 Incidental Dewatering

Channel construction in Reach A will also require incidental dewatering. Seepage flow from groundwater and through the existing or former Silver Bow Creek channel bed may contribute water to the construction areas which could complicate construction efforts. Therefore, these waters will be pumped to settling basins constructed for floodplain dewatering systems (Section 3.1). Fit-in-field collection trenches and sumps may be required to concentrate and collect seepage flows.

3.3 TAILINGS/IMPACTED SOIL REMOVAL

Tailings/impacted soil removal is one of the key components for the remediation of Silver Bow Creek according to the ROD. This section of the FDR presents the objectives for removal of tailings/impacted soil, criteria used to define the base of tailings/impacted soil, and data used to identify the extent and volume of these materials. Specific design components with excavation of tailings/impacted soil are presented for Subarea 1, Reach A.

3.3.1 Objectives

Tailings/impacted soils are the primary contaminant source for the SSTOU. The ROD addresses three important ways in which tailings/impacted soils contaminate Silver Bow Creek and its associated groundwater system: 1) Tailings/impacted soils in direct contact with ground water; 2) Infiltration of precipitation through tailings/impacted soils; and, 3) Erosion of tailings/impacted soils into Silver Bow Creek. According to the ROD, "tailings/impacted soils will be removed from the 100-year floodplain, as defined by the CH2M Hill (1989) report, where:

1. Tailings/impacted soils are saturated by groundwater during any part of the year;
2. In-situ STARS treatment cannot reliably immobilize the contaminants, for example, due to the thickness of the tailings/impacted soils, proximity of the tailings/impacted soils to groundwater, or lack of appropriate buffer materials between the treated tailings/impacted soils and the groundwater; or
3. The treated tailings/impacted soils could be eroded back into the stream by natural lateral stream migration, avulsion, overbank flow or flood events and subsequent erosion."

In Subarea 1, estimates presented in the RI (ARCO, 1995a) indicate that 67 percent of tailings/impacted soils are saturated by ground water or overlay saturated materials. The confined nature of the floodplain and the relatively steep stream gradient in Subarea 1 increase the probability of adverse flood impacts on in-situ STARS treated areas. The negative effects of saturated tailings/impacted soils and streambank erosion preclude implementation of in-situ STARS in this subarea. Consequently, all tailings/impacted soils in Reach A of Subarea 1 will be removed.

To plan the remediation of the floodplain, it is necessary to define the horizontal and vertical extent of tailings and determine which materials require removal based on the ROD criteria. The primary work product is therefore a staking plan by which the horizontal and vertical extent of tailings/impacted soil can be defined such that a specified percentage of the total quantity of tailings are removed at a statistically specified level of confidence. Completion of this design element requires use of existing data sets that meet data quality criteria for design and use of techniques for estimation of the extent of tailings that provide a means for evaluating the effectiveness of the design. Other work products associated with this effort include identification of areas where saturated materials may be encountered during excavation of tailings/impacted soil and the development of volume estimates to be used as the basis for other design elements. These work products provide supplemental information to potential contractors who may provide bids for remedial construction.

3.3.2 Design Criteria

As prescribed by the ROD, tailings/impacted soil will be defined by applying the "order-of-magnitude" criteria initially developed during the RI for the SSTOU. The order-of-magnitude concept was based on the observation that contaminant of concern concentrations generally decrease with depth in a test pit, and often there is an order-of-magnitude decrease (ten times reduction) in the concentrations of several of the contaminants of concern within a relatively small vertical depth interval. Although the order-of-magnitude concept was not originally intended to be tied to specific concentration values, it was found that no objective rules could be developed for identifying the order-of-magnitude break without reference to some threshold concentration levels. These threshold levels were agreed to by the Agencies and ARCO during meetings related to the supplemental studies for tailings/impacted soil (See ARCO, 1997c) and were used to provide general guidelines that correspond roughly to contaminant concentrations that are a factor of ten (order-of-magnitude) less than average contaminant concentrations measured in undiluted tailings. For Subarea 1, the order-of-magnitude criteria for defining the vertical extent of tailings/impacted soil is defined by a two-tiered rule, as follows:

1. The first tier in determining the vertical extent of tailings/impacted soil requires that the total concentrations of four of the six contaminants of concern be lower than the following general guideline concentrations:

    - Arsenic generally less than 200 milligrams/kilogram (mg/kg);
    - Cadmium generally less than 20 mg/kg;
    - Copper, lead, and zinc generally less than 1,000 mg/kg; and
    - Mercury generally less than 10 mg/kg.

2. The following "modifiers" to the above criteria provide guidance for determining the vertical extent of tailings/impacted soil where an order-of-magnitude break based solely on absolute concentrations is not apparent:

    - Ceiling concentration values can be used for individual constituents that, in the absence of concentrations of other constituents exceeding the values presented above, result in an "appropriate" interval identified as tailings/impacted soil; and
    - Additional modification to initial concentration levels may be required where metals concentrations increase with depth at locations where contaminant concentrations in surface or near-surface soil do not indicate the presence of tailings/impacted soil.

Data used to describe the extent of tailings must be complete and comparable, using appropriate analytical methods and reported with sufficient detail to support evaluation by these criteria. For construction purposes, horizontal accuracy of these data need to support estimation of staking points to a minimum 10 foot grid. Vertical accuracy of these data needs to support estimation of staking elevations to a minimum precision of 0.5 feet. The following discussion describes existing data that meet these criteria.

3.3.3 Supporting Data

Delineation of the horizontal extent of tailings/impacted soil is presented in Sheets M4a through M4d, Existing Conditions. This boundary is compiled from lines provided in electronic format by ARCO in 1997 and modified by Maxim Technologies based on field verification completed in November 1997 (Maxim et al, 1998). Field verification included excavation of horizontal extent sample pits, which are also shown on Sheets M4a through M4d. All mapping was referenced to surface topography and stream channel locations provided by photogrammetric data compiled from 1996 aerial photography by Horizon. Verification sample locations and selected horizontal extent boundaries were located using resource-grade Global Positioning System (GPS) instrumentation.

Vertical extent of tailings/impacted soil is based on 363 test pits within the horizontal extent of tailings/impacted soil sampled and analyzed in accordance with the SSWP for Tailings/Impacted Soil Investigations submitted by ARCO in 1996 and 1997 (ARCO, 1997c). Test pits were excavated on an approximate 150 foot sample spacing and involved sample collection at 4-inch intervals to a depth below the suspected extent of tailings/impacted soils based on visual observation. Metals analyses and the application of the "order-of-magnitude" criteria, described above, were then used to define the vertical extent of tailings/impacted soil at each location. Horizontal and vertical survey control was also established for these test pits using survey-grade GPS instrumentation. Test pit locations and the elevation at the base of

tailings/impacted soil determined by the "order-of-magnitude" criteria are presented in Sheets M4a through M4d and listed in Appendix D.

To address the saturated tailings/impacted soils removal criteria, groundwater information was developed to determine the depth and extent of tailings/impacted soils saturation. Identification of staking points where saturated material may be encountered in tailings/impacted soil excavation is based on groundwater elevations derived from a potentiometric surface developed by Montana Bureau of Mines and Geology (Abdo, 1998a) using piezometer data collected in September 1997. Horizontal and vertical survey control was established for these test pits using total-station survey instrumentation that tied into survey control established by Druyvestein, Johnson, and Anderson (DJ&A) for ARCO in 1997. Survey control points are presented in Sheets M5a through M5d and listed on Sheet M2.

Volume calculations for excavated material during tailings/impacted soil excavation are based on surface elevations acquired for test pit locations, described above, and selected survey locations established by DJ&A for ARCO in 1997 within the horizontal extent of tailings/impacted soil. Survey locations (DJ&A) were further censored to discard survey locations at or near the existing stream channel. It was determined that inclusion of points adjacent to the channel would bias the estimation of streambank elevations on the low side because of the disproportionate number of points obtained in the lower portion of the channel cross-section. This would result in calculations that would underestimate the volume of tailings/impacted soils to be excavated under the staking plan. Test pit surface elevations for Subarea 1, Reach A are presented in Appendix D.

3.3.4 Design Components

RI data (ARCO, 1995a) indicated that a high percentage of the area covered by tailings/impacted soils is saturated in Subarea 1. Design-level data collection confirmed this. In addition, all of the tailings/impacted soils are included within the relatively narrow floodplain where they could be subject to erosion over time. A determination was made in the ROD that all tailings/impacted soils in Subarea 1 would have to be removed. The emphasis of the design for tailings/impacted soils is therefore determining the extent of tailings/impacted soils to be removed.

Sheets M5a through M5d and M5f present the staking plan for excavation of tailings/impacted soil developed from the supporting data. This plan is laid out within the horizontal extent of tailings/impacted soil at even 50 foot intervals and is differentiated by those points where saturated material may be encountered in tailings/impacted soil excavation. Sheet M5e lists associated excavation grades which are estimated by geostatistical methods using the ARCO test pit data described above. This sheet also reports groundwater elevations which are derived from the potentiometric surface (Abdo, 1998a). Horizontal and vertical survey control use a project datum based on the Montana State Plane Coordinate System, South Zone, NAD27 and NAV29.

3.3.4.1 Determination of Excavation Surface

Excavation grades are an expression of the elevation at the base of tailings/impacted soils minus an over-excavation factor used to assure that a specified percentage of material is removed at a specified confidence level. Whereas the IDR used depth of tailings/impacted soil as the estimation variable, this estimation process used elevation at base of tailings/impacted soil for several reasons. First, as represented in Sheets M4a through M4d, elevation exhibited a meaningful trend in relationship to distance down stream and cross-sections across the floodplain. Secondly, elevation at the base of tailings/impacted soil exhibited stronger spatial correlation not exhibited by the depth variable. As a practical matter, using elevation at base of tailings/impacted soil as a cut grade in construction eliminated any error that would be introduced by

estimating surface elevations at the staking points. Finally, by encountering only one source of estimation error, the calculation of the over-excavation factor is simplified.

Elevation at base of tailings/impacted soil was estimated using three geostatistical estimation techniques. Where meaningful spatial correlation existed in the data, kriging methods available in Arc/Info were used to estimate elevation at the base of tailings/impacted soil. This was a preferred method given the spatial correlation exhibited by the data and the ability to evaluate estimation error in support of calculation of an over-excavation factor. Grid estimates were developed on a 10 foot interval and assigned to the 50 foot staking grid where they coincided. Kriging was used in all areas of Subarea 1, Reach A except in the area between the I-90/15 bridges where sufficient mixing of materials had taken place so as to indicate that no spatial correlation existed in the test pit data representing this area.

In the area between the I-90/15 bridges, elevation at base of tailings/impacted soils was estimated using the minimum value reported by test pits in this area. This method was appropriate given the small sample size in this area and the variability of the base of tailings/impacted soils elevations. This value was applied to all staking points on the 50 foot grid within this area. This estimation method is the non-parametric equivalent to a parametric confidence interval statistic. This value expresses the maximum confidence one can have that the maximum percentage of material is removed given the available data. It is noted that this estimation technique will likely result in significant over-excavation of material in tailings/impacted soil removal. However, in the absence of more data, this is the most defensible approach that will assure a specified percentage of material will be removed at a specified confidence level. This method has only been applied in the area between the I-90/15 bridges and has not been used elsewhere in Subarea 1, Reach A.

Finally, estimations of elevation at the base of tailings/impacted soil was modified for selected staking points throughout Subarea 1, Reach A to address "feathering" in the vertical extent of tailings/impacted soils at selected boundaries of the horizontal extent of tailings impacted soil. Through kriging or non-parametric techniques it was recognized that, in some instances, estimated excavation grades at these boundaries likely do not reflect the geometry at the floodplain boundary. It is noted that where test-pit data provides coverage at or near this boundary, kriged estimation of elevation of tailings/impacted soil adequately represents this feathering phenomenon. However, where there is insufficient coverage, estimations are likely to result in an excess of excavation of material during tailings/impacted soil removal.

"Feathered" excavation grade modifications were made in a limited number of cases (42 staking points out of 642 total for tailings/impacted soil excavation). This approach was considered for staking points only if the following conditions could be met:

- The staking point was at or near the horizontal extent of tailings/impacted soil that was identified in the field to likely exhibit a "feathered" floodplain geometry;
- Sufficient test pit data existed between the stream bank and the horizontal extent of tailings to support calculations; and
- Sufficient vertical control data (survey locations established by DJ&A for ARCO in 1997) existed at the horizontal extent of tailings/impacted to support calculations.

Where these conditions were met, feathered excavation grades were calculated using linear interpolation of the elevation at base of tailings/impacted soil exhibited in test pit data and surface elevations reported for vertical control data. It is noted that this approach is applied in the absence of corroborating sample data, a situation that needs to be addressed in subsequent designs. However, for this design, it was felt that by ignoring this phenomenon, significant excess of excavation would likely occur that would be unwarranted.

No excavation elevations were determined for the staking points in the existing channel because the existing channel will not be removed under the order-of-magnitude break criteria; rather, it will be addressed under in-stream sediment removal in Section 3.4. In addition, no excavation elevations were determined for certain points appearing on the staking plan which fall between points on the fifty foot grid. These intermediate points are needed only to establish final floodplain elevations and can be ignored during excavation.

3.3.4.2 Determination of Over-Excavation Factor

Because of the variability of the excavation surface elevation, removal of material to the base of tailings/impacted soils surface would result in significant contaminated material remaining in the floodplain. Calculations based on the statistical properties of the base of tailings/impacted soils surface indicate that about 80 percent of the tailings/impacted soils would be removed if this method of excavation were pursued. It was therefore recognized that additional over-excavation would be required in order to reduce the amount of contaminated material left in the floodplain. ARCO (1997c) and Maxim (Technical Memorandum dated 1/3/97 in Appendix D) developed a statistical method of determining the effects of over-excavation on the percentage of tailings/impacted soils removed. Key components of this calculation are: 1) Determining the relation between over-excavation and percentage of tailings/impacted soils removed; 2) Placing statistical confidence limits on the calculation of percentage removal; and, 3) determining a cost-effective over-excavation factor.

The relation between depth of excavation and percentage removal of tailings/impacted soils depends on the statistical properties of the excavation surface. For a distribution of depths that approximates the normal distribution (Subarea 1 test pit data are approximately normally distributed), the mean depth and the standard deviation of the depth are the determining parameters in the calculation. Also needed is the spatial relation of the data which is determined from a variogram of depths with distance between points. Appendix D contains the calculation of the relation of percentage removal of tailings/impacted soils with depth based on 350 test pits excavated in Subarea 1. Table 3.3-1 summarizes the results of this calculation for a range of over-excavation depths.

TABLE 3.3-1
PERCENTAGE VOLUME REMOVED AS A FUNCTION OF OVER-EXCAVATION DEPTH
Reach A (Subarea 1) - SSTOU Remedial Design

Over-Excavation Depth (feet)	Volume Tailings/Impacted Soils Removed (percent)
0.00	80.9
0.25	86.7
0.50	91.3
0.75	95.1

The information presented in Table 3.3-1 demonstrates an increase in percentage of tailings removed with each one-quarter foot increment of over-excavation depth. However, the rate of increase gradually decreases. The agencies decided that the increase in percentage became sufficiently small around a half foot over-excavation depth that they would require no more than 90% removal of tailings. Ninety percent removal corresponds to an over-excavation depth of 0.43 feet.

The calculation presented above does not include information on the confidence we can expect in the removal percentage. A statement of confidence can be arrived at by using the tolerance interval method which provides a certain confidence (e.g., 95 percent) that the desired coverage has been obtained. If a large number of samples have been used in the calculation, this adjustment (increase in required depth to obtain the desired removal) is quite small. However, if the calculation is based on relatively few samples, the adjustment can be quite large. This is the reason that the full data set for Subarea 1 has been used to obtain the over-excavation depth rather than using the data set limited to Reach A.

Calculation of the adjustment to the over-excavation depth using the one-sided tolerance interval method are found in Appendix D. The adjustment was calculated using the nominal 0.43 foot over-excavation based on 90 percent removal, 95 percent confidence, and the statistical distribution of the data from 350 test pits. The adjusted over-excavation depth is 0.55 feet which is sufficiently close to half a foot that construction drawings used a half foot over-excavation. Because this value was derived for the entire subarea, it is possible that it will not be met within every reach of the subarea.

3.3.4.3 Verification of Tailings/Impacted Soils Removal

Removal of tailings/impacted soils will be verified through a QA/QC sampling program which will determine if 90 percent of the tailings are being removed with 95 percent confidence. This sampling program will be designed to provide a statistical measure of whether the removal goal has been met. It will not be used to search for limited "hot-spots" of contamination that may remain in the floodplain. It will require collection of a significant number of samples before any determination of the efficacy of the removal can be made because, without a large number of samples, statements of 95 percent confidence cannot generally be made.

Because a large number of verification samples over a significant portion of Subarea 1 must be collected before statements of compliance with the removal goal can be made, the sampling program will not be used to redirect excavation to previously excavated areas. If verification sampling indicates that the removal goal is not being met over substantial areas, the over-excavation depth may be increased in as-yet unexcavated areas to comply with the removal goal. It is not expected that any decrease in the over-excavation depth will be made within Reach A because of the difficulty of maintaining 95 percent confidence in the removal goal over limited portions of Subarea 1. However, if evaluation of the verification samples for Reach A as a whole indicates that a reduction in over-excavation depth is warranted, then consideration will be given to reducing the depth in succeeding reaches of Subarea 1.

The statistical constraints on determining if the remedial goal is being achieved largely prevent redirection of equipment for additional excavation activities. However, the large data base of excavation depths developed during remedial design gives the agencies confidence that the remedial goal will be met especially since similar statistical methods will be employed to evaluate the verification data as were applied to the design data base. This approach to verification of removal of tailings/impacted soils will also allow the contractor to excavate to the elevations shown on the plans and conduct his operation without delays and interruptions of the construction sequence.

3.3.4.4 Determination of Saturated Materials

Groundwater elevations were estimated using triangulated irregular network (TIN) methods available in Arc/Info. Grid estimates were derived from resulting TINs on a 10 foot interval and assigned to the 50 foot staking grid where they coincided. No expressed confidence about these estimates is implied and results are presented solely to provide an indication of where saturated materials may be encountered during tailings/impacted soil excavation. Out of 642 staking points used to prescribe excavation of materials, 409 are points where saturated materials may be encountered. This suggests that at least 64 percent of the

tailings/impacted soil area is saturated at the depth of excavation. The average depth of these saturated materials is 1.51 feet which accounts for approximately 57,180 cubic yards of material.

3.3.4.5 Volume Determination

The volume of excavated tailings/impacted soil was calculated based on the depth of material excavated at staking points. In order to calculate depth, surface elevation was estimated using kriging methods available in Arc/Info. Grid estimates were developed on a 10 foot interval and assigned to the 50 foot staking grid where they coincided. Calculation of volume estimates considered each staking point to have equal weight on an area basis. Based on these estimates and assumptions, the average depth of excavated tailings/impacted soil is 2.80 feet which accounts for approximately 166,800 cubic yards of material. As with groundwater elevations, no expressed confidence about these estimates is implied and results are presented solely to give an indication of the volume of material that may be encountered during tailings/impacted soil excavation.

3.4 IN-STREAM SEDIMENTS REMEDIATION

In-stream sediments are one of the three contaminated media identified for remediation in the ROD (MDEQ and EPA, 1995). This section details the design for remediation of in-stream sediments in the SSTOU, Subarea 1, Reach A. The measures are designed to be in compliance with the criteria set forth in the ROD and the Comprehensive Remedial Design Work Plan (ARCO, 1997a).

3.4.1 Objectives

The presence of contaminated sediments in the stream bed provides an on-going source of contaminants directly to Silver Bow Creek. The ROD states that all contaminated fine-grained sediments in depositional areas are to be removed from the stream and placed in repositories with tailings/impacted soils and railroad materials outside the floodplain. This will prevent future contamination of Silver Bow Creek. The ROD defines "fine-grained sediments" as in-stream sediments less than one millimeter in diameter. The ROD further requires that the channel bed and streambanks be reconstructed after in-stream sediment removal.

3.4.2 Design Criteria

Studies undertaken by ARCO (1997c) did not find the expected relation between fine-grained material and higher metals concentrations in streambed deposits. Therefore, the agencies determined that it was not logical to pursue the ROD criteria for in-stream sediment removal and another, more rational method was sought. Additional information developed by the agencies' contractors (Maxim, 1998e) showed that in-stream metals contamination, although distributed throughout differing depositional forms, was confined to relatively shallow depths. This information was combined with a change in construction methods to develop new in-stream sediment removal criteria. Because the complete reconstruction of the channel, including bed materials, is part of the agency design, in-stream sediment removal will be necessitated by channel reconstruction and these sediments will be replaced with clean material. Thus, removal of in-stream sediment will occur through reconstruction of the channel, and the goal of reducing direct contact between contaminated in-stream sediment and Silver Bow Creek will be accomplished.

Because the new channel will not follow the existing stream alignment in much of Reach A, much of the existing stream channel will be abandoned and these sediments will no longer directly interact with Silver Bow Creek. In these areas, removal of former in-stream sediments will be dictated by the order-of-magnitude criteria as part of the floodplain tailings/impacted soils removal. Inspection of the in-stream metals data collected by ARCO (1997c) and Maxim (1998e) indicates that almost none of these materials meet the order-

of-magnitude break criteria for removal from the floodplain. Therefore, in-stream sediments will only be removed and taken to a MWRR where the new channel overlays the old channel and channel reconstruction mandates the removal of the sediments.

Two approaches will be taken to address in-stream sediments in Reach A under the revised criteria:

1. In areas where the stream channel will be reconstructed and the existing and new stream channels coincide, in-stream sediments will be removed during reconstruction and hauled to the MWRR. In these areas, a one foot depth of in-stream sediments will be removed and hauled to the MWRR. If channel construction requires further excavation, material removed from deeper depths will not be hauled to the MWRR but can be used for floodplain backfill. As further protection from potential remaining metals contamination, the new channel design requires placement of a minimum of 1½ feet of clean material over the remaining in-stream sediments.

2. Due to the relocation of the stream channel in the remainder of Reach A, much of the existing stream channel will be abandoned. In-stream sediments that remain in the portions of the existing stream channel that will be abandoned will be treated as floodplain sediments. These sediments meet the general requirements for being below the order of magnitude decrease in contaminant concentrations and will not be removed as tailings/impacted soils but will remain in place. As part of the reconstructed floodplain, they will no longer be in direct contact with surface water.

3.4.3 Supporting Data

Areas of contaminated sediments based on 1996 field data were shown in the IDR (ARCO, 1997c). Because in-stream sediments are subject to downstream transport, the data ARCO presented in the IDR are indicative of general sediment depositional and chemical characteristics but do not indicate specific areal contaminant distributions. Metals concentration data obtained in this study did not correlate well with type of deposit or texture of the material.

Based on data from four boreholes drilled within the existing stream channel to a depth of 10 feet below the stream bed surface (Maxim, 1998e), relatively elevated concentrations were observed in certain metals in the shallow depths (generally less than about three feet) in some borings (Table 3.4-1). Data presented in Table 3.4-1 show a marked decrease in arsenic and metals concentrations below the three foot depth, an indication that most in-stream sediment contamination is near the surface (i.e. when all sediment data is considered together). In all samples submitted for analysis from these borings, including those from the shallowest depths, arsenic and metals concentrations were lower than the order-of-magnitude tailings criteria used for removal of floodplain sediments (Section 3.3.2). Therefore, in-stream sediments that will not be in contact with the new stream channel will not be removed.

3.4.4 Design Components

The design components required for in-stream sediment removal are excavation of contaminated in-stream sediments and disposal of contaminated sediments.

3.4.4.1 Excavation of In-Stream Sediments

The stream channel will be reconstructed throughout the length of Reach A. Where the existing and new stream channels coincide, the existing stream channel sediments will be excavated to the depth required to place clean bed material. In these areas, the upper one foot of removed material will be taken to the MWRR

and the remainder will be used as floodplain backfill. Upstream of the diversion structure, excavation will be performed using coffer dam and pumping systems to exclude water from the excavation. Excavation will be performed in non-flowing conditions downstream of the diversion structure following diversion of Silver Bow Creek. Because clean fill will be placed to a depth of at least one foot in these areas, the stream should be isolated from any potential remaining contamination.

TABLE 3.4-1
STREAMBED SEDIMENT SAMPLING RESULTS
Reach A (Subarea 1) - SSTOU Remedial Design

			Total Concentration (milligrams/kilogram)					
Lower Depth (in)	Soil Class (1)	pH (s.u.)	Arsenic	Cadmium	Copper	Lead	Mercury	Zinc
12	GP	4.8	<2	24	767	40	<0.2	1330
30	ML	5.9	11	19	3150	200	1.5	2570
36	ML	5.2	<2	14	767	150	<0.2	1040
42	GP	5.4	<2	<2	671	56	<0.2	860
48	SM	6.8	<2	2	30	56	<0.2	2340
30	SP	7.0	<2	6	6	58	<0.2	573
48	SW	6.8	<2	<2	30	20	<0.2	424
54	SP-SM	6.8	4	<2	30	<20	<0.2	220
66	SP-SM	6.2	6	<2	40	53	<0.2	270
30	SM	6.8	<2	17	671	56	<0.2	662
36	SM	6.8	<2	14	1460	53	<0.2	827
12	SM	7.2	<2	<2	56	30	<0.2	75
60	SP-SM	7.0	<2	<2	51	40	<0.2	100
36	SP	6.8	36	91.8	836	200	<0.2	1480
42	SP	6.8	3	24	45	30	<0.2	230
48	SP	6.8	4	4	230	40	<0.2	376
54	SP	6.2	12	2	51	30	<0.2	250
60	SP	5.2	12	2	13	40	<0.2	70

(1) - Classification according to the ASTM Unified Soil/Classification System
GP = poorly graded gravel; ML = silt or silt with sand; SM = silty sand; SP = poorly graded sand;
SW = well graded sand; SM = poorly graded sand with silt.
< = less than the detection limit

Locations to be excavated are indicated on Sheets M7a through M7d. The estimated volume of sediments to be excavated upstream of station 12+00 is 800 cubic yards using the one foot excavation depth. The volume to be removed based on coincidence of existing and new stream channels below station 12+00 (using an excavation depth of one foot) is about 1,200 cubic yards.

3.4.4.2 Disposal and Treatment of Contaminated Sediments

Contaminated sediments excavated from Silver Bow Creek will be hauled to MWRR 2 when they are sufficiently dewatered to permit haul without loss. In-stream sediments will be lime amended at the same rate as the master rate for tailings/impacted soils which is identified in Section 3.7 of this report.

3.5 CONSTRUCTION HAUL ROUTES

Haul routes will be necessary to transport waste materials and borrow from and to the remediated floodplain. A transportation plan, which discusses regulatory compliance and safety, engineering controls, vehicle specifications, and haul roads, has been prepared for Subarea 1 and is presented in Appendix E-1. This section describes the design and location of the primary haul routes for construction of the remedy in Reach A of Subarea 1.

3.5.1 Objectives

The ROD and the Comprehensive Remedial Design Work Plan do not specifically address haul road construction or location. These documents do, however, require the transport and treatment of tailings/impacted soils and floodplain material. Because of the large volume of tailings/impacted soils along Silver Bow Creek, the most economical method of transporting material from and to the floodplain is by large, off-road haul trucks. Haul roads will been designed for large haul trucks to efficiently transport these materials.

3.5.2 Design Criteria

Tailings/impacted soil in Reach A and from the downstream haul road crossings of the floodplain will be transported to MWRR 2, located at the western end of Reach A. Approximately 166,800 cubic yards of tailings/impacted soils will be transported an average distance of about ½ mile. For floodplain reconstruction, approximately 84,600 cy of borrow material will be transported from one source (BA-10), located approximately ½ mile west of Rocker. An additional 15,500 cy of borrow will be hauled from BA-10 to MWRR 2 for use in the repository cap.

The following design criteria were developed for the design of construction haul routes for Reach A construction:

- Minimize haul lengths;
- Minimize the disturbance of contaminated areas;
- Minimize effects on the public;
- Maximize safety; and
- Utilize a cost effective design.

3.5.3 Supporting Data

Maxim conducted a limited field investigation in 1998 (Maxim et al, 1998) to determine subsurface soil information in areas proposed for haul routes. This investigation was limited to Subarea 1 and consisted of excavating shallow test pits, soil sampling, and laboratory testing to determine subgrade bearing capacities for construction haul routes. Laboratory testing included sieve analysis, liquid limit-plastic limit tests, and California Bearing Ratio tests. Appendix E-2 contains the laboratory reports for this subsurface soil investigation.

3.5.4 Design Components

For construction haul routes within or near Reach A and Subarea 1, there are three design components: 1) Haul road design; 2) Stream, diversion channel, and utility crossings; and, 3) Traffic control. Only general design parameters have been developed as design and construction of both primary and secondary haul roads will be the responsibility of the Contractor.

3.5.4.1 Haul Road Design

The approximate alignment of the primary haul road, which is about 16,000 feet long, is shown on Sheet M11. The Contractor will have the responsibility to field locate the primary haul roads. Any deviation from the locations indicated on Sheet M11, will require approval by the Owner's Representative. The locations of the secondary haul roads are not shown and will be determined by the Contractor after initial approval by the Owner's Representative.

The Contractor will be required to design and construct the haul roads and approaches to road and railroad crossings for the anticipated loads and sizes of trucks for hauling mine wastes and borrow materials. Adequate drainage measures will be required, including culverts at drainage crossings and road ditches. The Contractor will also be responsible for providing all maintenance and dust control for the haul roads. Where the haul roads will parallel railroad lines, the edge of the road running surface will be required to be at least 20 feet from the centerline of the tracks. Public road and railroad crossings will be constructed to maximize vehicle visibility and stopping distance.

Haul roads constructed in Reach A and accessing MWRR 2 will be reclaimed after completion of the work for Reach A. Haul roads will be regraded to the original ground topography and the stockpiled topsoil from the haul road areas will be replaced. Revegetation of the haul road will be completed in accordance with the revegetation plan described in Appendix J.

3.5.4.2 Stream, Diversion Channel, and Utility Crossings

Several utility, stream, and diversion channel crossings are required as part of the haul roads. Sheet M11 shows the locations of the stream and utility crossings for the primary haul road. The location of diversion channel crossings will be determined by the Contractor after initial approval by the Owner's Representative. The diversion channel crossing design is shown on Sheet I25 and discussed in Section 3.2. Utility crossings will be constructed in accordance with the appropriate utility requirements.

The primary haul road crosses the creek in two locations downstream of Reach A. Where these sections of haul road cross areas of tailings/impacted soils, an area sufficient to construct the road cross-section will be cleared and grubbed prior to construction. Tailings will be excavated to the staked elevations as shown on Sheet M5f. Crossings of Silver Bow Creek below Reach A will be designed and constructed by the Contractor with approval from the Owner's Representative. The crossings shall be designed to remain in place for at least 3 years with a culvert or other flow conveyance designed to pass approximately 229 cfs (approximate 2-year flow of Silver Bow Creek). Flows exceeding the 2-year event will be allowed to overtop the existing streambanks, similar to natural free-flow conditions. The road approaches to the crossings will be constructed at or below the floodplain surface grades to allow passage of flood flows with minimal backwater. The road fill over the flow structures will be adequate to provide minimum cover requirements over the flow structures and maintain maximum road grades, but shall be designed as small as possible to create minimal flow

obstruction to flood flows. The crossing shall include erosion protection for the flow structures and fill embankments.

Construction of the diversion channel crossings to access the floodplain from the primary haul road shall be accomplished in accordance with the design shown on Sheet I25. The number of diversion channel crossings will be left to the discretion of the Contractor. The diversion channel crossings will be required to be removed at the completion of construction activities. If winter shut-down is necessary, the crossings will be required to be entirely removed by the Contractor prior to the Contractor leaving the site. When construction recommences, diversion channel crossings will be reconstructed.

Utility crossings for the haul roads will be required to contain measures to prevent damage to existing buried utilities. There are at least five types of buried utilities crossed by the planned haul roads: 1) the existing Silver Lake water line; 2) the existing water line for the Town of Rocker; 3) a natural gas line; 4) a fiber optic line; and 5) the Butte sewage sludge line. All known utility crossings are identified on Sheet M11. Other utilities may exist that are not listed here or shown on the drawings. The Contractor will be required to design and install adequate structural measures to prevent damage to the utilities. The crossings must be designed to remain in place for three years. The designs and installation procedures shall be submitted to the appropriate Utility and the Owner's Representative for approval at least 14 days prior to installation. The Contractor will be responsible for coordination with the appropriate utility representatives to determine locations and crossing requirements. The Contractor will be required to have all utilities located at the exact crossing locations prior to excavation, determine their depths below the ground surface, obtain soil engineering properties of the overburden material, and conduct an engineering analysis to design an appropriate crossing structure.

3.5.4.3 Traffic Control

Traffic controls will be required to be appropriate for the type and size of haul equipment used. It is anticipated large off-road trucks, scrapers, and excavation equipment will be used during construction activities. Right-of-ways will be established and signs and/or flag persons will be used along public roads at haul road intersections and entrances/exits as well as along haul road routes to maintain traffic flow and safety. The Contractor shall coordinate the required crossings with Butte-Silver Bow County.

The Contractor will be required to submit a Traffic Control Plan outlining traffic controls, signing, barricades and access control stations in accordance with Part VI of the Manual on Uniform Traffic Control Devices (MUTCD) and the United States Department of the Interior Bureau of Mines Information Circular No. 8758. The Traffic Control Plan shall be submitted to the Owner's Representative within 14 days after the Notice to Proceed.

Traffic control will also include control of the two crossings of the Rarus Railway. Rarus Railway will require either automatic signals at these crossings or one flagger at each crossing. The Contractor shall coordinate the required crossing system with Rarus Railway. Flaggers will only be required at railway crossings on days that trains are running. Presently, trains run two days a week although the schedule is subject to change.

3.6 MINE WASTE RELOCATION REPOSITORY

This section describes the design for MWRR 2 which will be used for relocation of all mine wastes excavated during Reach A construction. The MWRR design is intended to be in compliance with the criteria set forth in the ROD (MDEQ and EPA, 1995) and the Comprehensive Remedial Design Work Plan (ARCO, 1997a). An evaluation of repository types and locations was completed by Maxim (1998b) and provides additional background into several alternative designs considered for MWRRs.

3.6.1 Objectives

The ROD requires that excavated waste materials "be relocated to safe, local repositories clearly outside of the present 100-year floodplain as defined by CH2M Hill (1989)." Objectives for MWRRs described in the ROD include the following:

- All mining wastes placed in a repositories must be treated with STARS technology;
- The repository cover must be revegetated;
- The repositories must be clearly located outside the 100-year floodplain of Silver Bow Creek; and
- The repositories must be protective of human health and the environment.

If repositories could not be designed to meet these objectives in locations proximate to Silver Bow Creek, then the ROD provided a contingency plan for locating the repositories off-site.

3.6.2 Siting and Design Criteria

A discussion of siting and design criteria are presented in Maxim's (1998b) alternatives analysis report for MWRR. The following presents a summary of these criteria:

Siting Criteria

- Repositories must be located further than 200 feet from a fault that has displacement in Holocene time, and not be located in an area with a ten percent or greater probability that the maximum horizontal acceleration in earth material will exceed 10 percent of the acceleration of gravity (0.10 g) in 250 years, unless shown that all facility components are designed to resist the maximum horizontal acceleration;
- Locate repositories outside of the 100-year floodplain (CH2M Hill, 1989);
- Depth to groundwater beneath the repository must be no less than 10 to 20 feet;
- Minimize impacts to residents, communities and transportation corridors, to the extent feasible; and
- Provide sufficient storage volume.

Design Criteria

- Waste contained in the repositories should be placed with a minimum setback of 30 feet from all public right-of-ways and 50 feet from private property boundaries; permanent features associated with the repositories, such as drainage, sediment control, and access structures, shall be within the property boundaries of land acquired by MDEQ or land designated for use as a repository site;
- Percolation of water from the repositories may not result in exceedances of MDEQ Circular WQB-7 standards for groundwater (MDEQ, 1995);

- Soil loss due to erosion should not exceed 2 tons of soil per year per acre from revegetated surfaces;
- Runoff water from drainage areas upslope of the repositories must be routed around the repositories;
- If feasible, borrow areas should be used for MWRR to minimize disturbance;
- The post construction topography of the MWRR should blend with the surrounding natural topography to the extent reasonably possible and be consistent with the designated end land use; and
- Where appropriate, MWRRs will be constructed to accommodate development of the recreational corridor end land use (e.g. Silver Bow Greenway).

3.6.3 Supporting Data

ARCO presented preliminary designs in the IDR (ARCO, 1997c) for Subarea 1. Three potential repositories (MWRR 1, MWRR 2 and MWRR 3) were located immediately adjacent to Reach A. The IDR design included amending the tailings material and revegetating the amended tailings material. Near-stream repositories, such as MWRR 1, MWRR 2 and MWRR 3, as well as off-site repositories were evaluated for effectiveness and cost in the *Alternatives Analysis for Mine Waste Relocation Repositories* (Maxim, 1998b). The evaluation of repository designs primarily focused on:

- Potential impacts to groundwater, due mainly to arsenic concentrations in repository leachate;
- Costs associated with siting repositories in off-stream areas where groundwater impacts should be less pronounced; and
- Improvements to the repository cover system by incorporating design features that would reduce the amount of leachate generated.

This evaluation indicated that siting a repository off-stream does not have sufficient advantages over siting the repository near-stream to warrant the additional transport cost. Near-stream repositories need to provide adequate protection to groundwater resources which can be provided by using an evapotranspiration cover consisting of suitable soil and vegetation to reduce percolation rates and/or by incorporating low permeable liners in the cover.

3.6.4 Design Components

Important design components for the MWRRs include site selection, capacity, revegetation, seismic stability, and erosion. These components are described in detail in the following sections. Lime incorporation, which is a important aspect of repository construction, is described in Section 3.7. Sheets M9a through M9f show repository construction details.

3.6.4.1 Site Selection

Of the three near-stream repositories proposed in the IDR (ARCO, 1997c), MWRR 2 was selected for use as a repository for remedial construction in Reach A. The layout of MWRR 2 presented in the IDR was modified to provide the additional storage capacity needed to accommodate mine wastes excavated from Reach A by

extending the footprint of the repository and increasing its thickness as compared to the IDR design. MWRR 1 and MWRR 3 were not selected for several reasons. The primary reason is that both repositories had a much lower storage capacity to footprint ratio. This lower capacity to footprint ratio results in a greater land area disturbance which would require additional cover material quantities. Other reasons for dropping MWRR 1 from further consideration were the large areas of bedrock and sand textured soils underlying the proposed repository in the eastern portion and a shallow depth to groundwater (i.e. less than 10 feet) in the western portion. Another factor in dropping MWRR 3 from further consideration for Reach A construction was the longer haul distance to Reach A than MWRR 2.

MWRR 2 meets all of the relevant site selection criteria listed in Section 3.6.2. Seismic, depth to groundwater, and storage volume requirement criteria are discussed below. Impacts to residents, communities and transportation corridors should be minimal because MWRR 2 is located a considerable distance from residences and public roads. The nearest maintained road is I-90/15 which is located uphill and generally out of view of MWRR 2.

3.6.4.2 Mine Waste Material Characteristics And Repository Capacity

Appendix F-1 provides calculations for determining the weight and volume of waste to be placed in the repository. Estimated weights, densities and volumes relating to the repository layout and capacity are shown in Table 3.6-1. Because the estimated waste storage capacity of 197,750 cubic yards exceeds the amount of amended and compacted waste (171,900 cubic yards), the design should be adequate to accommodate all wastes from Reach A.

TABLE 3.6-1
MINE WASTE MATERIAL CHARACTERISTICS AND REPOSITORY CAPACITY
Reach A (Subarea 1) - SSTOU Remedial Design

CHARACTERISTIC	VALUE
Volume of in-place tailings and other wastes	169,100 cy
Estimated dry density of in-place waste	95.3 lbs/cf
Tailings/Impacted soils in-place moisture content	20% by weight
Maximum laboratory dry density of recompacted amended waste[1]	109.6 lbs/cf
Optimum moisture content of amended waste	16.9% by weight
Estimated dry density of recompacted amended waste (95% of maximum dry density)[2]	104.1 lbs/cf
Estimated volume of recompacted amended waste	171,900 cy
MWRR 2 total capacity	220,200 cy
MWRR 2 waste storage volume	197,750 cy
MWRR 2 cover soil volume	22,450 cy

Notes: 1 - American Society of Testing Materials Method D698
2 - based on a lime rate of 52 tons lime kiln dust per 1,000 tons waste (dry weight)
cy = cubic yard; lbs/cf = pounds per cubic foot

The MWRR will be constructed in conjunction with lime amendment methods discussed in Section 3.7. Waste materials brought to the repository will not be at a specified moisture content although they must be dry enough to be hauled without significant spillage. Because many of these materials originate in a moist or saturated environment, the contractor will need to make provision for drying the materials sufficiently to permit compaction in accordance with the specifications. Such provisions will include providing space for spreading, mixing and turning materials to increase evaporation and combine wet and dry materials. Addition of lime may alter the moisture characteristics favorably and decrease the amount of drying required.

3.6.4.3 Waste Handling, Amendment and Placement

An estimated 1,500 cubic yards of waste material per day will be transported to the repository. Dewatering of the waste material in the floodplain is expected to result in an average moisture content of 20 percent by weight for waste material delivered to the repository.

Tailings are proposed to be amended with lime following transport to the repository. Methods for applying the lime amendment will be selected by the Contractor. The Contractor will need to demonstrate that the selected method sufficiently mixes the lime with waste. Section 3.7.4.4 further describes lime mixing applications.

It is likely that there will be trial and error involved in the contractor achieving an acceptable amendment method, while also treating the waste at the design amendment rate. Along with applying amendments, the contractor will also need to dry those wastes which contain excess moisture. Compaction of waste is required to be completed at moisture contents within the range of (+/-) 2 percent of optimum moisture. Material testing data indicate that amendment of the waste with lime kiln dust results in raising the optimum moisture content while at the same time lowering the as-received moisture content as a result of the conversion of calcium oxide in the lime kiln dust to calcium carbonate. This reaction will facilitate reaching an acceptable moisture content for compaction.

Both the amendment and drying of waste will likely be completed in lifts of waste within the repository as tailings/impacted soils are excavated and delivered to the MWRR. Based on the estimated daily transport volume of 1,500 cubic yards, an area of approximately 48,400 square feet would be needed to place the waste materials in a one-foot lift. It is possible that, given the layout of the repository, the contractor may need to amend and dry waste at adjacent or nearby areas and then transport the waste to the repository for final placement.

3.6.4.4 Soil Cover

Revegetation of MWRR 2 is important for controlling percolation rates into the wastes and preventing erosion. Proper cover design, as described in the following provisions, will optimize conditions for revegetation establishment. More details of MWRR revegetation are found in Section 3.12 and Appendix J.

1. Lime will be applied to 100% of the requirement in the uppermost three feet of the tailings waste material to insure no acidification potential.

2. Cover soil will be placed to a minimum depth of 22 inches across the repository. The cover soil will consist of topsoil stripped from the site and from imported borrow material. Stripped topsoil will first be placed over the amended waste to a depth of approximately six inches. Sandy loam material obtained from Borrow Area 10 will then be loose spread in two lifts across the repository and compacted by tracking with a dozer to achieve the minimum thickness requirement. The stripped topsoil will contain noxious weed seeds and is therefore being placed beneath the imported borrow material to prevent weed propagation.

3. The seed mix will include grasses with root depths that penetrate through the sandy loam material and alfalfa which has root depths that will penetrate below the sandy loam material and into the amended waste material. Selection of the species was based in part on providing plants which will readily support evapotranspiration for removing moisture from the repository.

3.6.4.5 Erosion

Appendix F-2 contains an analysis of erosion rates from the revegetated repository surface. Erosion rates are estimated to be approximately 2.1 tons per acre per year, which slightly exceeds the design criteria of 2.0 tons per acre per year.

3.6.4.6 Runon, Runoff and Sediment Control

Runon from land upgradient of MWRR 2 is routed around the repository by two ditches. The ditches are sized for passing a 100-year storm runoff event (Appendix F-3). The ditches will be lined with Type 2 stone underlain with bank stabilization fabric to prevent erosion. The west runon ditch will flow into Sediment Basin S-3 (see Railroad Materials Remediation). The east runon control ditch flows into a relocated drainage channel on the east side of MWRR 2, then into Sediment Basin S-2 (see Railroad Materials Remediation).

Runoff during construction and from the finished repository surface will be directed to two runoff ditches, one on the east side and one along the south end of MWRR 2. The ditches are sized for passing a 100-year storm runoff event (Appendix F-3). The ditches will be lined with erosion mat. For post-construction revegetation work, the erosion mat will be temporarily removed, the ditch area revegetated, and then the erosion mat will be replaced. Each runoff ditch will flow into a small construction sediment pond for sediment control. The sediment ponds will remain in place after construction activities are complete and will remain in service until the Agencies determine that erosion from the repository surface is not a threat to Silver Bow Creek water quality. The ponds are designed to trap sediment from peak flows up to and including the 25-year event. Each sediment pond will have an emergency spillway capable of passing at least the peak flow from the 500-year runoff event.

Other erosion control measures (e.g. silt fence and/or straw bales) will be installed by the contractor around the repository, as needed, during construction. After placement of all wastes, the permanent runon control ditches will be constructed.

3.6.4.7 Geotechnical Evaluation

Appendix F-4 contains a geotechnical evaluation of MWRR 2. The site is generally underlain by sandy loam textured soils with an exposure of bedrock present in one area of the repository. Planes of weaknesses (e.g. clay lenses) along which failure surfaces could develop are not apparent. The sandy loam encountered in the borings was medium dense and not saturated which indicates that it should not be prone to liquification under seismic loading.

Geologic and seismic information reviewed for the project indicate that the geotechnical conditions in the project area are generally favorable for siting a repository. There are no recent faults (Holocene age) within one-mile of Silver Bow Creek. The closest Holocene age fault appears to be the Vendome Horst, located between Butte and Whitehall, Montana, approximately 20 miles east of the project area (Stickney and Bartholomew, 1983). The bedrock acceleration in the project area has been estimated at 0.20g (20 percent

of the force of gravity) with a 90 percent probability of not being exceeded in 250 years (Algermissen, 1983). A seismic stability analysis conducted for the repository design indicates that for a bedrock acceleration of 0.20g, the repository has a factor of safety of 1.8 against failure. The minimum allowable factor of safety used for the design is 1.3.

3.6.4.8 Hydrogeology

Wells 1GW-1056 and 1GW-1057 were installed in March 1997 by ARCO to investigate groundwater conditions at the site. Depth to groundwater in these wells varies from 11.5 feet at well 1GW-1056 to 19 feet at well 1GW-1057 (Johnson, D. 1998, personal communication). Depth to groundwater likely increases to the south where alluvial deposits are thicker adjacent to Silver Bow Creek.

Because the existing wells will be destroyed by construction of the repository, MDEQ plans to install monitoring wells at the repository to determine the post-construction quality of groundwater near the MWRR.

3.6.4.9 Groundwater Quality

The MWRR alternatives analysis report (Maxim, 1998b) calculated the general condition for percolation through the repository and eventual discharge to groundwater. Table 3.6-2 shows the estimated metal and arsenic concentrations in the percolate water, in background groundwater samples obtained near the site, and Circular WQB-7 Standards.

Review of Table 3.6-2 indicates that arsenic is the principal constituent in the water percolating from the repository which could result in exceedances of Circular WQB-7 standards. This is partly attributed to measurable concentrations of arsenic in background groundwater sampled near Whiskey Gulch. An analysis of the characteristics of the percolate water mixing with groundwater (Appendix F-5) indicates an arsenic concentration in groundwater at the toe of the repository of 0.017 mg/L, slightly below the Circular WQB-7 standard of 0.018 mg/L. Calculations used for determining the arsenic concentration in groundwater did not take into account attenuation of arsenic levels in leachate from the repository. Laboratory testing performed by Maxim (1998b) indicate that a substantial portion of leached arsenic should adsorb to soil underlying the repository and thereby reduce impacts to groundwater quality.

3.6.4.10 Access Road

MWRR 2 is located just north of old Highway 10. While Route 10 is no longer used as a primary access route and neither the Montana Department of Transportation nor Silver Bow County wishes to maintain its use, it will be the primary travel corridor for maintenance of MWRR 2.

3.6.4.11 Topography

The topography of the repository generally blends with topography of surrounding areas. Constructed slopes of the repository will be at 4H:1V or less. Slopes in this range are present throughout the immediate vicinity of Subarea 1. The south embankment slope of the repository is the most visible. A swale incorporated into the face of the south slope breaks its continuity and should improve its visual appearance.

3.6.4.12 End Land Use

The end land use for the repository will be a controlled access area that prohibits grazing or recreation. A barbed wire fence will be constructed around the repository to facilitate establishment of vegetation and limit unauthorized access.

TABLE 3.6-2
METAL CONCENTRATIONS IN LEACHATE SOLUTION
FROM AMENDED TAILINGS MATERIAL
Reach A (Subarea 1) - SSTOU Remedial Design

Sample Location	Concentration (mg/L)					
	Arsenic	Cadmium	Copper	Lead	Mercury	Zinc
Lysimeter 07D14; 40 and 90 cm depth, collected 1991 and 1992; mean concentrations (RRU and Schafer and Assoc., 1993)	0.208	0.0096	0.121	0	nm	1.53
Lysimeter SPW3-S, depth 45 cm, mean concentrations (Schafer and Assoc., 1997)	0.175	0.009	0.182	0.01	nm	0.717
Synthetic Leachate, Amended Tailings (Maxim, 1998b)	0.21	<.015	0.13	<.150	<0.0005	<.030
Background Groundwater Quality - Well C-15, located in Whiskey Gulch (ARCO, 1995a)	0.0114	0.0009	0.002	0	0.0001	0
Circular WQB-7 Standards (MDEQ, 1995)	0.018	0.005	1	0.015	0.00014	5

Notes: mg/L = milligrams per liter; nm = not measured; data from Maxim (1998b)

3.7 LIME RESOURCES

Lime addition to mine wastes is an important method of controlling acidity and reducing the mobility of tailings metals. Therefore, all mine wastes will be treated with lime before final disposition in the MWRR. This section addresses the objectives, design criteria, supporting data and design components for lime resources for Reach A of Subarea 1.

3.7.1 Objectives

The ROD stipulates that the tailings/impacted soils, in-stream sediments and railroad materials relocated to MWRRs will be treated with STARS technology (MDEQ and U.S. EPA, 1995). For the specific remedy for Reach A of Subarea 1, STARS treatment will be applied to MWRR 2. STARS technology pertains to the use of primarily liming amendments and various incorporation methods to chemically neutralize active and potential acidity, and reduce the solubility of metals in contaminated materials. This is followed by revegetation to further stabilize the waste and reduce infiltration (Reclamation Research Unit and Schafer and Associates, 1993).

3.7.2 Design Criteria

To accomplish the goal of reducing acidity and metals migration, several design criteria were developed for the amendment of the waste material:

- All mine waste materials will be limed at a rate equal to or greater than the sum of the active and potential acidity;
- Most waste will be amended at a master lime rate to simplify construction handling;
- Selected "hot spots" with high lime requirements will be limed at their respective lime rates plus a factor of safety of 1.25;

- In order to minimize the possibility of metals migrating from the base of the repository, lime will be incorporated in the basal four feet of the MWRR in a manner that ensures 100 percent direct contact of the lime with the waste material;

- In order to provide additional root zone beyond that provided by the MWRR soil cap, lime will be incorporated in the upper three feet of the MWRR in a manner that ensures 100 percent direct contact of the lime with the waste material; and

- In remaining areas of the MWRR, lime will be incorporated in a manner that ensures 80 percent direct contact of the lime with the waste material.

3.7.3 Supporting Data

Preliminary designs for the identification and application of lime amendments were presented in the IDR (ARCO, 1997c). The IDR identified lime kiln dust from Continental Lime in Townsend, Montana and "Econolime" from Continental Lime in Tacoma, Washington as lime sources to be used for remediation; however, the lime sources have changed since that time. The physical and chemical properties of the lime materials were measured and are described in the following section. The Reclamation Research Unit (RRU) further determined lime resource characteristics and the required amendment quantities for Subarea 1, and discussed application methods (RRU, 1997b). Some of these data are presented in Appendix G. Previous documents discussing liming rate determination and application methods in the Butte and Anaconda area also include RRU and Schafer and Associates (1993), RRU (1996) and RRU (1997a).

Laboratory determinations of acid-base account and exchangeable acidity for 44 tailings/impacted soil samples collected from Reach A were used to determine the liming requirements for Reach A. The analytical results are presented in Appendix G.

3.7.4 Design Components

Design components for lime resources include: (1) lime amendment sources; (2) lime amendment quality and quantity; (3) lime application rates; and (4) lime mixing methods and QA/QC.

3.7.4.1 Lime Amendment Sources

Several potential lime sources were evaluated for use in Reach A based on available supply, quality, and cost. Lime sources were evaluated according to the characteristics identified in Table 3.7-1. Lime sources will include cement kiln dust from the Holnam cement plant in Trident, Montana, and lime kiln dust from the Continental Lime plant in Townsend, Montana and the Montana Limestone Company plant near Warren, Montana.

3.7.4.2 Lime Amendment Quality and Quantity

The quality of these neutralizing agents varies based on the source and may even vary from each source over time. The exact quantity which will be available from each source is unknown. Testing has been conducted to determine preliminary estimates of lime quality at the three sources.

3.7.4.3 Lime Application Rates

The quantity of lime required for neutralizing the tailings/impacted soil is determined from the ECCE which adjusts the laboratory-determined CCE of the lime source for impurities, particle size and percent moisture.

The quantity of lime needed to amend the tailings/impacted soils is dependent on the potential acidity from sulfide minerals and the active acidity in the soil solution and exchange capacity. The lime rate is calculated using an equation (3.7-1) derived from the modified Sobek Method (Sobek, 1978; Schafer and Associates and Reclamation Research Unit, 1987), and SMP buffer. The quantity of lime required for Reach A of Subarea 1 will be dictated by a number of variables including analytical chemistry, excavation depth and engineering approaches to mixing lime with tailing materials.

$$\text{Lime Rate (tons } CaCO_3\text{/1000 tons waste)} = [(HNO_3\text{-S} + \text{Residual-S})31.25 + (\text{HCl-S})23.44 + \text{SMP buffer}] \quad \textbf{(3.7-1)}$$

As indicated in Figure 3.7-1, the majority of lime requirement values (38) are less than or equal to 29 tons $CaCO_3$/1000 tons for all of the 44 samples collected from Reach A. Based on these values, a master lime rate of approximately 29 tons $CaCO_3$/1000 tons was selected. This master rate will be used as the lime requirement for all of the representative tailings material whose application values are less than or equal to 29 tons $CaCO_3$/1000 (Figure 3.7-1). Figure 3.7-1 also shows that six of the 44 areas require liming rates higher than 29 tons $CaCO_3$/1000. Each of these areas will limed at the rate determined by equation 3.7-1 plus a 1.25 safety factor. The lime requirements, including the safety factor, for the areas having the six highest values are presented in Table 3.7-2.

TABLE 3.7-1
GENERAL CHARACTERISTICS EXAMINED FOR LIME AMENDMENT MATERIALS
Reach A (Subarea 1) - SSTOU Remedial Design

Parameter	Comments
Particle grain size	Amendment particles larger than 60 mesh (0.25 mm) will not be counted in the ECCE for the material.
Percent Moisture	Amendment rate calculated on a dry weight basis.
Calcium Carbonate Equivalence (CCE)	Amendment quality calculated on 100% calcium carbonate equivalence.
Composition ($CaCO_3$, CaO, $Ca(OH)_2$, MgO)	Determination of which compounds are available to neutralize acidity.
pH	pH provides an indication of lime components and neutralizing capacity.
Electrical Conductivity	Examined to determine characteristic of material
Sodium Adsorption Ratio	< 12
Element	*Total Concentration**
As	< 30 mg/kg
Cd	< 4 mg/kg
Cu	< 100 mg/kg
Pb	< 100 mg/kg
Hg	< 5 mg/kg
Zn	< 250 mg/kg

Notes: *If metal levels of amendments are greater than these values, the amendments may still be acceptable depending on the level of contamination in the soil to be amended.

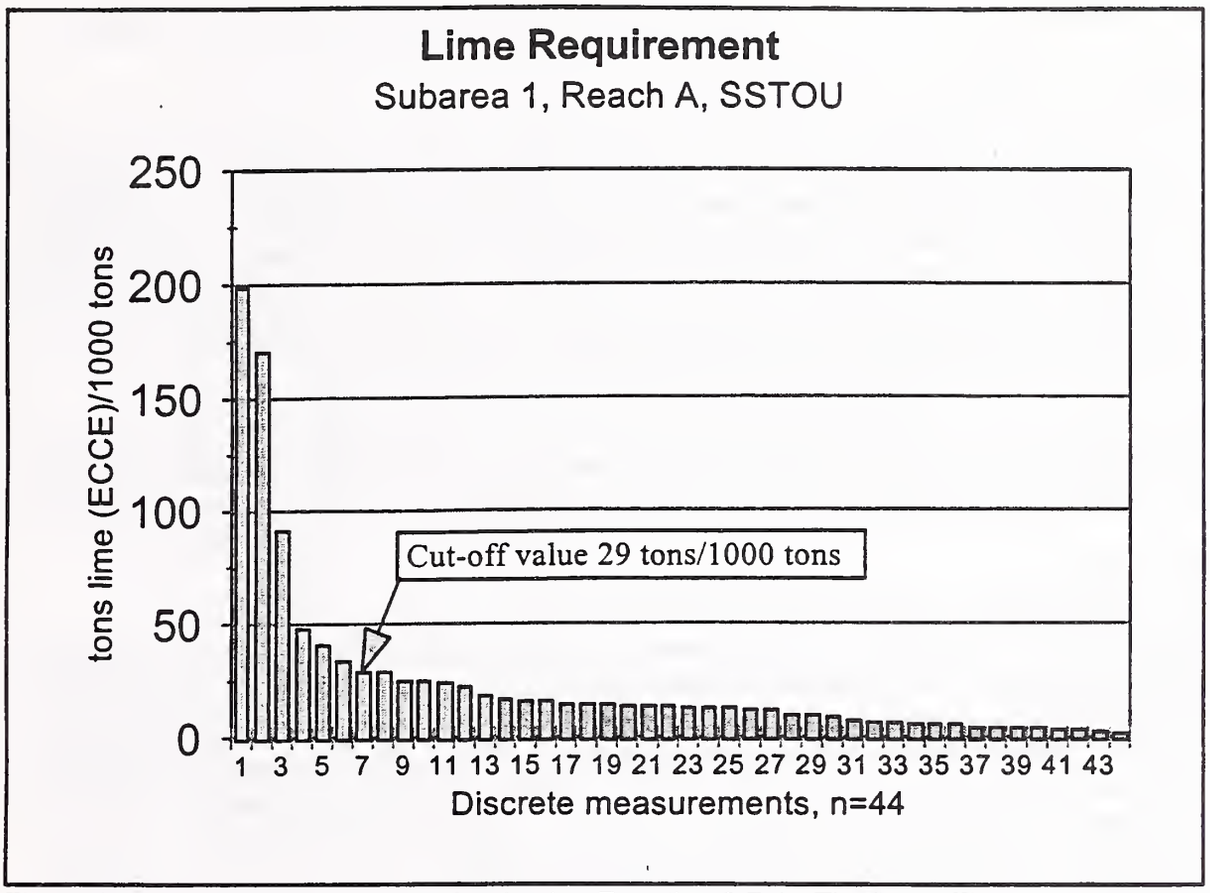


Figure 3.7-1. Lime rates determined using Equation 3.7-1. The "cut-off"value was used to determine the master lime rate for all lime requirements less than this value.

The advantage of using this method is that it allows a single lime rate to be applied to most of the tailings material. The disadvantage is that much of the material will be over amended, which translates into hauling and mixing more lime than what is actually needed. Using the lime rates discussed above, approximately 9,400 tons of lime as $CaCO_3$ (ECCE) are required to adequately amend the 217,600 tons of tailings/impacted soils and instream sediments.

TABLE 3.7-2
LIME REQUIREMENTS FOR SIX HIGHEST VALUES
Reach A (Subarea 1) - SSTOU Remedial Design

Sample Location	Lime Requirement (tons $CaCO_3$/1000 tons)
1N-1006	42
1S-1075	51
1S-1032	60
1N-1010	114
1N-1081	213
1N-1064	248

3.7.4.4 Lime Mixing Methods

General Lime Mixing

Complete and effective mixing must be achieved so that the amendment is interspersed with the soil and waste particles. At least 80 percent of the waste material matrix must be in direct contact with the lime amendment for wastes placed between the upper three foot and lower four foot levels in the MWRRs. Amended waste material in the upper three feet and lower four feet of the MWRRs must be amended so that 100 percent of the waste matrix is in direct contact with the lime amendment. Sampling and testing requirements for lime mixing are detailed in the project Construction Quality Assurance Plan.

The method of lime incorporation is not specified here to allow the construction contractor some flexibility in determining the most efficient and cost effective method(s) to be used. Several lime amendment methods have been used successfully in past projects, and are presented below.

Lime Incorporation Methods

In-situ incorporation with multiple passes with tillage equipment was successful in STARS (RRU and Schafer and Associates, 1993), Anaconda Revegetation Treatability Study (RRU, 1997a), and the Governor's Demonstration Project (Schafer and Associates, 1997) in mixing the amendment into the waste material. Agricultural tillage, with multiple passes at right angles to each other, was effective in amending the upper 0 to 6 inches of waste, but deeper tillage using a modified Baker plow or BOMAG mixer was necessary to effectively mix lime deeper into the profile (up to two feet). Typically, multiple passes (two to four) are made at right angles to each other. Surface application of lime amendment followed by ripping with a dozer is not an effective mixing method, and should not be considered. Mixing lime amendment with waste material using a grader or other device has proved effective. The waste is placed in windrows, and lime mixed into it with the grader. A variation on this theme is to mix the lime and waste material together using an excavator. Lime amendment is dumped onto the waste, and mixed with the bucket of the excavator. A pug mill has also been used successfully to mix lime amendment and waste material at a former coal waste repository site in central Montana (Dollhopf and others, 1994).

Liming of Top Three Feet of Repository

Due to the proximity of wastes in the top of a repository to water infiltrating through the cap, and the need to provide a suitable plant root zone, special attention must be given to the amendment of these wastes. Therefore, wastes placed in the top three feet of the MWRR, will be analyzed separately for lime requirement. One composite sample will be collected per 5,000 cy of waste material designated for the upper three feet of the repository, and analyzed for acid-base accounting (ABA). This material will then be amended with lime to 100 % of the requirement.

Quality Assurance

MDEQ will conduct quality assurance testing during construction of MWRRs. Testing will include assessment of lime quality being mixed with wastes and determination of whether lime has been mixed sufficiently with wastes to meet the stated specifications. A Construction Quality Assurance Plan has been prepared for RA construction.

3.8 CHANNEL AND STREAMBANKS RECONSTRUCTION

This section details the design for channel and streambanks reconstruction in Subarea 1, Reach A of the SSTOU. Development of general guidelines, alternatives, and design criteria for meeting the objectives of the ROD (MDEQ and EPA, 1995) and Comprehensive Remedial Design Work Plan (ARCO, 1997a) with respect to channel and streambanks reconstruction is discussed in the *Conceptual Design Report* (Inter-Fluve and MEI, 1998). The *Conceptual Design Report* includes substantial discussion of assumptions that have guided the design process and thus they are not repeated here. Details of design components and criteria not previously discussed in the *Conceptual Design Report* are included herein. This section details the designs selected only for the SSTOU, Subarea 1, Reach A. For Reach A, downstream of the Interstate bridges, a regulated flow alternative has been selected by MDEQ for channel reconstruction. This alternative was presented in Addendum One of the *Conceptual Design Report* (Inter-Fluve and MEI, 1998) and represents a significantly different direction in design approach from previous concepts. In the regulated flow channel, deformable streambanks will be implemented. Deformable banks are designed to allow for channel migration after the establishment of riparian vegetation.

Upstream of the diversion structure, from Lower Area One to the downstream Interstate bridge crossing, a non-deformable bank will be implemented. This reach is upstream of the diversion structure and flows will not be regulated. The non-deformable banks in this reach are incorporated for the protection of infrastructure, including a railroad grade and the Interstate highway bridges, and because the reach is confined. Existing channel planform and average dimensions will be reconstructed following removal of tailings/impacted soils from streambanks and removal of in-stream contaminated sediments.

3.8.1 Objectives

The primary objective of channel and streambanks reconstruction is to allow for removal of contaminated materials from these locations and to reconstruct these locations following removal of such materials. In addition, the objectives stated in the ROD (MDEQ and EPA, 1995) and Comprehensive Remedial Design Work Plan (ARCO, 1997a) include remedial designs which "ensure the geomorphic stability of Silver Bow Creek under post-remedial conditions" (p. 69). The Comprehensive Remedial Design Work Plan states that the channel and streambanks will be designed "using 'soft' engineering procedures utilizing vegetation for streambank stability and aesthetic enhancement..." (p. 61), and will "emphasize a natural stream system that is allowed to meander" (p. 75). Mine reclamation ARARs establishing such objectives, including ARM 17.24.634 (previously codified as ARM 26.4.634) addressing reclamation of drainages, channels and floodplains, are identified on page A-24 of the ROD. The Comprehensive Remedial Design Work Plan further states that channel relocation to "facilitate construction dewatering and excavation of the tailings/impacted soils, streambanks and in-stream sediments" will be incorporated where appropriate (p. 76).

In addition to objectives of the RA as defined by the ROD (MDEQ and EPA, 1995) and the Comprehensive Remedial Design Work Plan (ARCO, 1997c), objectives of channel and streambank design include protection of infrastructure and prevention of channel migration into sensitive areas or outside the 100-year floodplain boundary (CH2M Hill, 1989).

3.8.2 Design Criteria

Within Reach A, there are two sections of stream channel that will be addressed with different criteria. Design criteria for channel and streambank reconstruction are divided into criteria for the upper section of Reach A and the lower section of Reach A, as delineated previously. Design criteria differ in that the upper section is confined by project boundaries and existing infrastructure, and therefore cannot meet the criteria established for a meandering channel.

For the Interstate bridges and any water line crossings within the upper section of Reach A, and the county road crossing in the lower section, the following criteria for protection of infrastructure will apply:

- Remedial Design of Silver Bow Creek will not affect hydraulic conditions at the completion of the Remedial Action in a manner that reduces the stability of existing infrastructure.

- Long-term infrastructure protection may require channel maintenance or repair.

Criteria have been developed for revegetation of all reconstructed channel banks within Reach A. These criteria are outlined and described in the *Conceptual Design Report* (Inter-Fluve and MEI, 1998) and are not repeated here.

3.8.2.1 Upper Section of Reach A

From the upstream end of Reach A (Subarea 1, SSTOU) at the western LAO boundary, to immediately downstream of the eastbound Interstate bridge, the existing channel is artificially straight and armored with riprap. Reconstruction of this section of channel will be constrained to the existing alignment, due to the confined nature of this area and the existence of piers for the Interstate bridges. This section will be reconstructed to the average existing channel dimensions and slope within the reach, and will be designed to be non-deformable, as opposed to a natural (deformable) channel design that allows meandering. Channel geometry and planform will, therefore, be dictated by existing conditions. Segments of channel adjacent to, and in the immediate vicinity of, existing infrastructure (i.e., bridge piers and water lines) will be excluded from reconstruction.

For those banks or channel areas that require the removal of tailings/impacted soils or contaminated in-stream sediments in this upper section of Reach A, the following criteria will be applied to channel and streambank reconstruction during final design.

Design Criteria for Designation of Construction Exclusion Areas:

- No construction will occur within 20 feet of existing infrastructure, including bridge piers and water lines.

Design Criteria for Selecting Banks that Require Non-Deformable Treatments:

- Where utilities, other infrastructure, or sensitive areas warrant protection from channel migration.

- Where the design channel location is within 50 feet of railroad grades.

Design Criteria for Streambed Material Gradations:

- Material gradations for riffle sections will approximate the average of the gradation curves generated from a Wolman pebble count analysis (Mussetter Engineering and Inter-Fluve, 1997).

- Selected material gradations will consider the gradations available at local gravel sources.

Design Criteria for Bank Toe, Non-Deformable Banks:

- Where non-deformable banks are required for protection of infrastructure adjacent to the channel, bank toe structure will be designed to withstand the shear stresses anticipated to the depth of scour

calculated for the 100-year flow event. The 100-year criteria is used to be consistent with other criteria for the protection of infrastructure.

Design Criteria for Upper Bank, Non-Deformable Banks:

- Upper bank height and top of bank elevation will be determined by channel geometry design, floodplain reconstruction and elevation criteria, and existing conditions where applicable.

- The lower boundary of the upper bank will be designed to correspond with the water surface elevation that creates moist soil conditions and supports plant growth on the banks.

- Upper bank structure will be designed to withstand the shear stresses anticipated up to the 50-year flow for the life of the erosion control fabric (2-5 years). This will be accomplished by using biodegradable erosion control fabric with wood stake anchoring techniques. Erosion control fabric will be selected to withstand the shear stresses generated by these flows and will be based on the manufacturer's published material specifications. The 50-year flow was selected to offer a high degree of protection against damage to the upper bank during the period of vegetative establishment with a minimum of additional cost beyond providing protection for lesser flow events.

- Revegetation is integral to the success of the reconstructed banks. Beyond the life of fabric integrity, stability will be dependent upon the success of revegetation efforts.

3.8.2.2 Lower Section of Reach A

The lower section of Reach A extends from the eastbound Interstate bridge downstream to the end of Reach A, a channel distance of approximately 5,600 feet. This section of Silver Bow Creek will be reconstructed to meet the criteria of the ROD (MDEQ and EPA, 1995) and Comprehensive Remedial Design Work Plan (ARCO, 1997c) which calls for a channel which is allowed to meander. Following construction of the remedial channel and banks, stream flow will be regulated such that all base flow (approximately 20 cfs) is available to the reconstructed channel. Flows greater than base flow up to approximately 50 cfs will also be available to the channel. Excess stream flow resulting from runoff or storm events will be diverted into the diversion channel (see Section 3.2). This regulation of flow will limit erosive forces in the reconstructed channel for a minimum of three years while stabilizing bank vegetation becomes established. Channel designs were based on the assumption that flows will be regulated, and therefore a greater level of armoring by bank toe materials and upper bank structures will not be necessary to provide protection from high flows during the period of vegetative establishment. Further explanation and justification for this regulated flow approach is provided in Addendum One of the *Conceptual Design Report* (Inter-Fluve and MEI, 1998). Designs for channel and bank remediation were developed according to the criteria listed below. Justification and explanation of the criteria listed are detailed in the *Conceptual Design Report* (Inter-Fluve and MEI, 1998).

Design Criteria for Cross-Sectional Geometry of Remedial Channel under Regulated Flows:

- Provide a channel cross-section with a constant bankfull capacity that ranges from 150 to 200 cfs. The design bankfull discharge will remain constant through each project reach.

- Provide a channel cross-section that allows for minor adjustment through bar development within the bankfull channel.

- Incorporate variability in cross-sectional dimensions which are appropriate for varying bedforms, including pools and riffles, but which do not vary significantly from the selected bankfull discharge dimensions.

- Average width/depth ratio for the bankfull channel will fall within the range of 10 to 15 for riffles and straight reaches, and between 7 and 12 for pools. Width/depth ratios may vary locally beyond these ranges but will maintain the selected average ratio for the reach.

- Elevations of installed bed material will accommodate anticipated winnowing of fine materials and settling of installed materials such that long-term channel capacity is consistent with other criteria.

Design Criteria for Channel Grade:

- The remedial channel will be designed to insure sediment continuity for flows encompassed by the mean flow duration curve, presented in the *Conceptual Design Report* (Inter-Fluve and MEI, 1998).

Design Criteria for Channel Planform:

- Channel sinuosity will be determined as a function of valley length and channel grade, according to the design criteria set forth for channel grade.

- A minimum ratio of bend radius (R_c) to channel width (W), $R_c/W > 4$ will be used to assist in the layout of channel planform geometry.

- A pool-riffle sequence will be determined relative to planform geometries.

- The channel bank will not be located within 50 feet of repositories, railroad grades, or other sensitive areas unless the location of the existing channel is currently within this range or other physical limitations dictate variance from these criteria.

- Where possible, and without affecting the integrity of bridges and other structures, channel alignment through bridges will be modified to reduce backwater effects or channel instability associated with existing channel alignment.

Design Criteria for Bed Material Gradations:

- A single bed material gradation will be selected for the lower section of Reach A in an effort to specify attainable and constructable materials for channel remediation.

- Material gradations will approximate the average of bulk samples reported in the *Channel Stability Analysis* (Mussetter Engineering and Inter-Fluve, 1997).

- Selected material gradations will consider the gradations available at local gravel sources.

Design Criteria for Reconstructed Banks under Regulated Flow Conditions:

- Banks will be constructed to withstand the shear stresses for flows up to 50 cfs for the life of the erosion control fabric (2-5 years). At flow levels associated with the 2-year event (229 cfs) and higher in Silver Bow Creek, greater than 50 cfs will flow into the reconstructed channel (see Table 3.2-1).

However, flow durations for the 2-year and greater events are extremely short, and the culvert headgates can be utilized to offer further flow control, if necessary.

- Revegetation is integral to the success of the reconstructed banks. Beyond the life of fabric integrity, stability will be dependent upon the success of revegetation efforts.

3.8.3 Supporting Data

All discharge values applied to stated return interval flows were determined through hydrologic analyses conducted as part of, and reported in, the *Channel Stability Analysis* (Mussetter Engineering and Inter-Fluve, 1997). Design discharges are summarized in the *Conceptual Design Report* (Inter-Fluve and MEI, 1998).

Geomorphic stability for the reconstructed channel will be dependent upon achieving equilibrium in sediment transport. To achieve equilibrium in sediment transport, channel slope and cross-sectional characteristics were developed to provide sediment continuity under a full range of flows. Channel geometry was developed as part of conceptual level design and is described in the *Conceptual Design Report* (Inter-Fluve and MEI, 1998). The HEC-RAS model used to evaluate sediment continuity is included in Appendix H-1. HEC-RAS output for final channel design is included in Appendix H-2. Model inputs are not included in the Appendices as they are available in other documents or components of this report. Inputs parameters for HEC-RAS models include discharge values and channel cross-section geometry. For all model runs, design discharges defined in the design criteria were used as input data. Cross-sections used for the sediment continuity analysis are described in the *Conceptual Design Report* (Inter-Fluve and MEI, 1998). Cross-sections used for final channel design are shown in the Design Sheets which accompany this report. HEC-RAS output includes channel and floodplain flow velocities, shear stress values, and water surface elevations, which are used to substantiate designs and to ascertain that design conditions meet design criteria.

Additional materials in the Appendix include computations for depth of scour and material gradation sizing for deformable streambank designs.

3.8.4 Design Components

For Reach A, downstream of the Interstate bridges, a regulated flow alternative has been selected by MDEQ for channel reconstruction. The basis for the regulated flow alternative is presented in Addendum One, *Conceptual Design Report* for Subarea One, Silver Bow Creek, SSTOU (Inter-Fluve and MEI, 1998). The design components for channel and bank reconstruction include a diversion and flow regulation system, a reconstructed channel and channel banks, and replacement of a county road crossing. The diversion and flow regulation system is described in Section 3.2 and detailed on Sheet I23. Replacement of the county road crossing is detailed in Section 3.9. Channel design components include channel bed, channel banks, and bank vegetation.

3.8.4.1 Channel Bed

Designs for the reconstructed deformable channel are detailed on Sheet I12. The channel bed is designed to have a material gradation that meets the criteria listed above. This gradation is consistent with that applied in the sediment continuity analysis performed as part of the *Conceptual Design Report* (Inter-Fluve and MEI, 1998). The specific gradation is detailed in the Technical Specifications. Bed material will be installed on the channel bottom between the channel banks, and under the channel banks to a point 10 feet behind the toe of the bank. This distance of 10 feet is considerably greater than would be necessary if the subgrade behind the bank toe were alluvial material. However, because the subgrade consists of fine grained or unknown material, additional bank toe gravel was incorporated into the design. In the event that the channel migrates

through bank erosion processes, there will be additional bed material available to serve as the channel bed. Because channel migration and bank erosion rates following degradation of stabilizing coir fabric cannot be estimated, a 10 feet width of bed material was selected as a balance between the high cost of installing greater widths, and the risk of installing lesser widths.

The depth of channel bed material, 1.5 feet, is based on the anticipated depth of scour (1.1 feet) at the regulated design flow of 50 cfs, and accounts for anticipated winnowing of fine materials following construction (approximately 0.5 foot). Based on maximum shear stresses determined from the HEC-RAS model for design channel conditions and the size of the material determined from an incipient motion analysis, four methods (Simons and Senturk, 1991) were used to determine the depth of scour expected in the proposed channel at 50 cfs. These methods showed that up to 1.1 feet of scour should be expected within the channel at severe bends. This condition, therefore, should represent a worst case scenario, and thus a conservative estimate of scour depth. Velocities and shear stresses used to calculate scour depths were derived from the HEC-RAS model developed for the design channel configuration (Appendix H-2). Calculations for these depths are included in the Appendices.

An additional 0.5 foot of streambed material depth is included to account for winnowing of fine materials and settling of the installed bed materials following construction. It is anticipated that winnowed bed material will be deposited as in-channel bars. This additional bed material fill diminishes channel capacity from the bankfull design discharge of 200 cfs, as described in the *Conceptual Design Report* (Inter-Fluve and MEI, 1998), to approximately 150 cfs. Both of these discharges are within the range of acceptable design discharges as stated in the design criteria above. It is anticipated that the additional bed fill will settle following construction such that the approximate bankfull design discharge of 200 cfs will be accommodated.

3.8.4.2 Channel Banks

Channel banks consist of compacted subsoil overlain by a cover soil and biodegradable erosion control fabric. The erosion control fabric will be keyed in at the toe of the bank below the channel bed fill and below the calculated depth of scour at the design discharge. The erosion control fabric was selected to withstand the calculated shear stresses in the channel at the design discharge of 50 cfs. Maximum bank shear stresses at the design discharge of 50 cfs were calculated using HEC-RAS and found to be approximately 0.8 lb/ft^2, far less than the reported tensile strength of the fabric, which for the specified material is approximately 4.5 lbs/ft^2. The highest shear stress values were consistently located in riffle sections of the channel. Three bank types are designed to incorporate bedform variability in the channel; including bank treatments for riffle and straight reaches, for pools and outside bends, and for inside bends. The difference in bank treatments, illustrated on Sheet I12, accommodates varying channel depths for pools, riffles, and inside bends.

At a few locations in the reconstructed channel, modeled shear stresses are higher at a flow of 50 cfs than for greater flows. This occurs at riffle cross-sections immediately upstream of pools. At these sections, the water is dropping into the pool. Hence, the velocities and shear stresses are higher than at other cross-sections. As the discharge increases above 50 cfs, the water surface profile is less affected by the drop. Shear stress is a function of slope. Therefore, since the water slope is less steep at higher discharges, the shear stress decreases at higher discharges. A flow of 50 cfs was, therefore, used as the critical discharge. Shear stress decreases at both higher and lower discharges up to bankfull conditions.

Due to the formation of secondary flow currents within a stream meander bend, all erosional forces are concentrated at the outside of bends. Secondary currents also cause the inside of meander bends to be a depositional area. Consequently, channel banks on outside bends incorporated different designs than inside bends. For outside bends, depth of scour and incipient motion analyses are required. For inside bends, no such analyses are necessary and designs were geared towards recreating point bar features.

3.8.4.3 Bank Vegetation

Streambank vegetation, as described below, includes seeding, live cuttings, and rooted stock. Seed will be installed during bank construction under the erosion control fabric. All other plant materials will be installed under separate contract during dormancy. The vegetation described below pertains only to channel banks, though it will be installed as part of the greater revegetation plan.

The long-term stability of the streambanks will be dependent upon successful revegetation of deep-rooted, woody riparian species and a relatively uniform cover of herbaceous species. Revegetation of the streambanks is separate and distinct from floodplain revegetation. Streambank vegetation is a component of channel bank design, and only includes the streambank revegetation zone. The streambank revegetation zone is considered that portion of the streambank covered with erosion control fabric extending from the elevation associated with the stream base flow (approximately 20 cfs) up-slope for approximately 1-2 vertical feet to the channel bankfull elevation. The soil moisture regime of the streambank depends on local hydrology and ranges from a saturated condition at the lowest elevations to a seasonally saturated and moist to dry condition at the upper elevations where the streambank transitions into the floodplain zone.

A combination of available information and expertise was used to assemble the streambank revegetation prescription including selection of plant material types, plant species, planting densities, and installation timing and procedures. Preliminary prescriptions for streambank revegetation were developed by a team of regional plant material specialists from the NRCS, mine reclamation specialists, mine regulators, and independent plant ecologists with considerable experience in local revegetation projects and familiarity with the ecology of local reference plant communities. These recommendations were then modified and finalized by Inter-Fluve based on further research and consideration. For example, the seed mix species list was modified due to poor availability of several desired species. Final planting densities of herbaceous tubelings and willow cuttings were confirmed after reviewing published literature on growth rates of comparable species (Thunhorst, 1993), and observations of nursery growth rates (Balleck, 1997 personal communication).

An important consideration affecting the performance of the revegetated streambanks will be the proximity of the streambank zone to the water table and capillary fringe. Compared to adjacent, elevated revegetation zones, the streambank zone will be less affected by year-to-year variations in climate, as streambank plants will benefit from access to moist soils associated with streamflow. In addition, any long-term view of streambank vegetation must consider the adaptive characteristics of naturally occurring riparian vegetation which, to varying degrees, will colonize certain areas and compete with or complement installed vegetation (Kaufmann et al., 1995).

Vegetative Establishment

The initial streambank plant establishment period is considered to be the first two growing seasons, a period over which minimal degradation of erosion control fabric will occur, and vegetation will not be required to provide streambank integrity. However, considerable fabric decay may occur between years two and five, and maturing vegetation will need to provide an increased amount of stability to reconstructed streambanks to account for decreases in fabric strength. After five to ten growing seasons, vegetation will be the primary component to retain and stabilize streambank soils, as erosion control fabric will have degraded substantially.

During the initial plant establishment period, seeded herbaceous species are expected to provide a visible and fairly uniform vegetated layer across the fabric covered areas. Installed cuttings and herbaceous tubelings will show a less significant presence during this period, as it takes time for the roots of installed plants to

colonize the rooting zones. The above-ground foliage of willows will similarly show moderate growth rates until roots are more established.

Between the second to fifth growing seasons, installed cuttings and herbaceous tubelings are expected to have a more visible presence, primarily in response to better developed root systems that will tend to spread laterally and produce considerable amounts of above-ground foliage. The combined effect of root reinforcement and development of a dense, above-ground foliage will bind soil particles and offer increased tractive force resistance at the soil/ water boundary (Gray and Sotir, 1996), and start to replace the function of the erosion control fabric.

After 5 to 10 years, the combined effect of the herbaceous ground cover layer and woody shrub layer should be sufficient to provide erosion protection for the reconstructed streambank. While difficult to predict, the coverage values of specific species or plant material types, while taking into consideration the response to natural forms of disturbance such as sediment deposition, beavers, rodents and ungulate browsing, are expected to provide substantial root reinforcement and a relatively uniform ground cover that will withstand flows of Silver Bow Creek after the diversion channel is abandoned.

A determination of streambank stability will be conducted annually to determine when the diversion channel can be abandoned. Between years 5 and 10 the streambanks may be declared sufficiently vegetated and stable, to the extent that the full range of annual flows can be introduced to the reconstructed channel, if the following criteria are met:

- Aerial coverage values for herbaceous vegetation are a minimum of 80% in each sampling unit and, on outside bends, at least 40% of the coverage of herbaceous species must be comprised of the installed tubeling species;

- Willow cuttings on outside bends must show 80% survival and at least one live stem must occur for each linear foot of stream on both the left and right banks in each sampling unit; and

- Willow cuttings on straight reaches must show 80% survival and at least one stem must occur for every three linear feet of stream on both the left and right banks in each sampling unit.

A sampling unit is defined as a segment of the streambank planting zone that is 100 feet long. The width of the planting zone is generally that area covered by erosion control fabric, extending from the elevation associated with base flow (approximately 20 cfs) to the elevation that corresponds to bankfull flow.

Planting Densities

Plant spacing or planting density is a function of the growth rates of installed plants, with consideration of an assumed mortality rate (20 percent), and the amount of time allowed for plant establishment. Since plant growth rates depend on a variety of physical conditions such as soil moisture regime, soil type, and growing season, it is difficult to precisely estimate rates of root and shoot growth and establishment. However, the cumulative resources of published literature (Thunhorst, 1993), extrapolation from growth rates observed in native plant nurseries (Bitterroot Restoration, personal communication), communication with other revegetation practitioners (Hoag, 1998 personal communication), and field observations of both naturally occurring streambank plant communities and existing streambank revegetation sites provide enough information to specify planting densities for specific plant material types.

Plant Materials

A wide range of plant materials were considered to revegetate Silver Bow Creek streambanks, including seed of herbaceous plants, bare-root stock, rhizomes, un-rooted cuttings, rooted cuttings, ball and burlap plantings, and rooted containerized stock grown in a wide range of container shapes and sizes. Ultimately, un-rooted cuttings, seed, and containerized herbaceous tubelings were chosen because they are the most suitable to meet the design criteria and constraints of the project site. Specific elements of each plant material type, including selection of plant species and planting densities, are discussed in the following sections. Further streambank revegetation details are provided in the Technical Specifications.

Cuttings

Dormant, un-rooted willow cuttings are a preferred type of plant material for use on Silver Bow Creek because they are a proven, inexpensive means to establish willows (Gray and Sotir, 1996; Hoag, 1994). Willows are generally well adapted to streambank conditions, and provide excellent root reinforcement and bank stabilization. If strict installation guidelines, detailed in the Technical Specifications, are followed, high survival rates can be expected. The following species of native willows, and the relative proportion of each, are specified.

Common Name	Botanical Name	Relative Proportion
sandbar willow	*Salix exigua*	90%
Booth or Geyer willow	*Salix boothi* or *Salix geyeriana*	10%

Planting densities and locations for willow cuttings depend on two factors; the type of bank treatment, and the planform position (i.e., inside bend, outside bend, straight reach). Specific guidelines for collection, storage, and installation are provided in the Technical Specifications.

Planform Position	Planting Density
Inside bends	none
Outside bends	3 per linear feet
Straight	1 per linear feet

Seed

An essential type of plant material required along the reconstructed streambanks will be herbaceous vegetation. The fine roots of herbaceous vegetation (grasses, forbs and legumes) provide root reinforcement of the upper soil surface, and above-ground plant structure helps dissipate erosive forces at the soil/water boundary (Gray and Sotir, 1989). Seed of herbaceous plants will be installed to provide relatively rapid colonization of desirable native species on reconstructed streambanks, and to provide stabilization characteristics more desirable than non-native species that currently exist on the site. The species and associated seeding rates for each are listed below.

Common Name	Botanical Name	Seeding Rate (PLS lbs/acre)
slender wheatgrass	*Agropyron trachycaulum*	5.0
mannagrass	*Glyceria grandis*	4.0
alkali cordgrass	*Spartina gracilis*	4.0
Baltic rush	*Juncus balticus*	0.5
wild licorice	*Glycyrrhiza lepidota*	0.5
broad-leaf bluebell	*Mertensia ciliata*	0.5
yellow monkeyflower	*Mimulus guttatus*	0.5
American vetch	*Vicea americana*	0.5

Specific guidelines for collection, storage, and installation are provided in the Technical Specifications.

Herbaceous Tubelings

Another form of herbaceous plants that will form an important component of streambank revegetation is containerized tubelings, or rooted nursery stock grown in relatively deep and narrow tubeling containers (3 to 10 cubic inches). The primary reason for utilizing this type of plant material is that two exceptionally desirable groups (genera) of streambank plants (sedge and bulrush) establish poorly from seed (Gray and Leiser, 1989; Ogden, 1996 personal communication), but establish well from tubeling containers.

Sedge and bulrush tubelings will be planted in clumps along outside bends on approximately 2 feet centers, a spacing sufficient to establish uniform coverage within 2-3 years (Thunhorst, 1993). In addition to providing streambank stabilization in the specified planting locations, installed tubelings will provide seed and vegetative propagules that can colonize adjacent areas. Within the streambank planting zone, these species will be located along the saturated fringe. Three species of herbaceous tubelings will be planted in the proportions outlined below.

Common Name	Botanical Name	Relative Proportion
water sedge	*Carex aquatilis*	35%
wooly sedge	*Carex languinosa*	15%
small-fruited bulrush	*Scirpus microcarpus*	50%

Specific guidelines for collection, storage, and installation are provided in the Technical Specifications.

Soil Requirements

The soil texture, or proportion of different sized soil particles including sands, silts, and clays (Brady, 1990), is important for both revegetation success and long-term integrity of the reconstructed streambanks. A soil such as a coarse-textured, gravelly sand will provide little cohesion and physical resistance to particle detachment and entrainment under tractive forces associated with flood flows. Additionally, in the drier, elevated portion of the streambank zone, coarse soils that lack fine textured soil particles (silts and clays) have a low water holding capacity which can limit establishment of desirable, erosion resistant vegetation types.

While recognizing the limited sources for uncontaminated, fine-textured subsoils and especially organic cover soils from in-situ locations and identified borrow sources of the Silver Bow Creek valley, long-term streambank success will require loamy soils to provide acceptable physical structure, cohesion, and water holding capacity. In addition, the upper four inches of the soil profile must have a minimum percentage of organic matter for adequate vegetative establishment based on soil fertility.

Soil requirements for the reconstructed streambanks include a subsoil and a cover soil. The specified soil gradations are generally consistent with soil characteristics found in Borrow Area 10. Streambank soils may be obtained from Borrow Area 10 or may be obtained from in-situ soils as discussed in Section 3.12.2.2. Cover soils are specified with a minimum organic matter content of 3%. It is recognized that such soils may be difficult to attain. Consequently, cover soil specifications and gradations are such that available borrow sources may be amended with organic matter (compost) to meet cover soil specifications. As an alternative, a single layer of subsoil, meeting the specified gradations, may be used instead of separate subsoil and cover soil layers, with the requirement that a specified percentage of organic matter (by weight) be incorporated into the upper four inches of the soil profile. Under this scenario, the upper four inches of soil would meet the stated gradation and organic matter requirements of the cover soil via amendment.

3.9 BRIDGE AND STREAM CROSSINGS

3.9.1 Objectives

Bridge and stream crossings within Reach A, Subarea 1 of the SSTOU include two Interstate bridges, two suspended water transmission pipelines, and one county road culvert crossing. The eastbound and westbound Interstate bridges are supported by piers on footings, several of which are near the banks of Silver Bow Creek. The suspended water pipelines have support structures which are also near the stream banks. The fifth crossing, a Silver Bow County gravel road, currently consisting of two culverts, is more influential on the channel form and profile. Objectives for design related to this type of crossing include protection of infrastructure and achieving geomorphic integrity in channel design. Objectives for protection of infrastructure are largely dictated by the ARARs presented in the ROD. Objectives related to geomorphic integrity are also stated in the ROD, though not specifically in relation to existing bridges and crossings. The *Conceptual Design Report* (Inter-Fluve and MEI, 1998), contains further discussion of the objectives for consideration of replacing or removing existing bridges and crossings. The discussion in this section of the report focuses mainly on the design of the new county road crossing. The areas around the bridge piers/footings and pipeline crossings structures will remain undisturbed to maintain their integrity.

3.9.2 Design Criteria

Criteria guiding the design of the county road crossing include requirements to protect infrastructure against flows up to a 100-year flow event, while minimizing backwater effects at the crossing. Specific design criteria for crossings and infrastructure were developed and detailed in the *Conceptual Design Report* (Inter-Fluve and MEI, 1998). These criteria are listed below:

- Remedial design of Silver Bow Creek will not affect hydraulic conditions at the completion of the RA in a manner which reduces the stability of existing infrastructure;
- Grade control will be incorporated at or downstream of bridges to protect bridges from potential long-term grade adjustments in the channel following the RA; and
- Long-term infrastructure protection may require channel maintenance or repair.

In addition to these criteria, designs are based on Standard Specifications for Road and Bridge Construction (Montana Department of Transportation (MDT), 1995). Silver Bow County has no published criteria for bridge or road crossings and defers to MDT. High water events at the crossing currently flow over the top of the road, causing disruptions to traffic flow and, more importantly, deterioration of the crossing which increases maintenance costs of the roadway. A design which prevents overtopping at this location is preferred.

The road crossing will consist of two culverts. One will be the primary channel conveyance culvert which will replace the existing two culverts. A second will be installed in-line with the diversion channel, and will have sufficient capacity to convey the design flow of the diversion channel. Design criteria for the diversion channel are detailed in Section 3.2.2. The culvert is located to provide effective drainage, but also to allow construction of the diversion channel and associated levees.

3.9.3 Supporting Data

The *Channel Stability Analysis* (Mussetter Engineering and Inter-Fluve, 1997) and the *Conceptual Design Report* (Inter-Fluve and MEI, 1998) presented discussions on the significance of maintaining vertical and horizontal controls at critical locations, and their contribution to the geomorphic stability of the remedial channel design. From the analyses presented in the *Conceptual Design Report*, it was determined that only three major vertical controls existed in Subarea 1, one of which was the existing culverts and embankment at the county road crossing in Reach A. Removal of the culverts could potentially allow upstream migration of a headcut which is currently being "controlled" at the culvert outlet. Since the channel design will include a new stable grade and eliminate this headcut, the reconstructed crossing can be utilized as a new vertical control to help maintain the proposed gradient.

The road at this crossing is maintained by Silver Bow County. Any alteration to the crossing must meet county requirements for culvert installations and road bed materials. As reported in the *Conceptual Design Report* (Inter-Fluve and MEI, 1998), the current crossing is deteriorating. It consists of a corrugated metal pipe (CMP) arch with approximate dimensions of 9.5 feet by 6.3 feet and, spaced 25 feet to the left, a second CMP arch with approximate dimensions of 6.2 feet by 3.6 feet. A headwall and wing walls were constructed of stone blocks and mortar was added at a later date to maintain the integrity of the walls. The walls, however, are failing (especially below the water line where mortar repairs were not made). Gaps in the wall near the culvert entrance indicate the presence of seepage flow problems. Downstream of the culvert outlet there is evidence on the channel banks of severe erosion from incision and headcutting, while the banks upstream of the culvert are stable. Further descriptions of existing bridge conditions are available in the *Conceptual Design Report* (Inter-Fluve and MEI, 1998).

The *Channel Stability Analysis* (Mussetter Engineering and Inter-Fluve, 1997) includes results from a HEC-RAS model performed for existing conditions through the existing county road crossing. This model indicates that the road crossing is currently overtopped between the 5-year and 10-year flow and that it creates considerable backwater at all flows. Hydraulic model outputs of design conditions at the county road culvert crossings, which are discussed subsequently and differ from existing conditions, are presented in Appendix H-2. These outputs relate backwater, expressed as water surface elevations, associated with various flows through the culvert.

Additional design justification and data included in Appendix H includes design rationale and calculations for culvert stilling basins based on an H-20 loading of the culverts and for the design culvert slopes.

3.9.4 Design Components

Design components for bridges/stream crossings include: 1) protection of Interstate bridge piers/footings and the water pipeline crossing structures; 2) replacement of the county culvert crossing; and 3) installation of a diversion channel culvert through the county road crossing.

3.9.4.1 Interstate Bridge Piers and Water Pipeline Support Structures

Design objectives for the upstream section of Reach A, which contains bridge piers for the Interstate Highway bridges and water pipeline crossings, include remedial channel construction to the approximate grade and channel dimensions of the existing channel. By replicating existing grade and channel conditions, including bed materials, the channel design will not affect the piers or the pipeline support structures in any way. To further protect existing infrastructure (i.e., bridge piers and water pipeline support structures), construction exclusion areas have been designated adjacent to, and in the immediate vicinity of, the existing structures.

3.9.4.2 Culverts

The objective of replacing the crossing at the county road is to improve the stability and planform alignment of the channel at the crossing. Replacement and reconstruction of the existing crossing will contribute to the vertical control of reaches upstream of the crossing, provide a horizontal control for the planform of Reach A, and benefit the stability of the system in both the short-term and long-term. New culvert design will reduce the backwater at all flows, thereby enhancing natural channel and floodplain function upstream of the culvert.

Two identical pipe-arch culverts will be installed for the conveyance of channel flows under the county road. One will be located in the reconstructed Silver Bow Creek channel. The second culvert, to be installed approximately 2.5 feet higher in elevation, will convey flow in the diversion channel for the life of the diversion channel, and will remain in place for overbank flow conveyance after diversion channel reclamation. Alignment of the culverts is shown on Sheet I4. The culverts are to be 70 feet in length, with cross-sectional dimensions of 7'7" x 11'10" (rise-by-span). They will be placed at a grade of 0.004 to maintain sufficient velocities to prevent silting, yet not create excessive velocities which would increase scour at the culvert outlets.

The structural design for the culvert crossing was based on standard H-20 loading. The minimum height of cover is slightly over 2 feet, which exceeds minimum cover requirements by approximately 6 inches.

The arch culverts were sized to reduce backwater effects Table 3.9-1 shows the backwater surface elevations under existing and proposed conditions. Based on the existing conditions HEC-RAS model (Mussetter Engineering and Inter-Fluve, 1997), flows spill over the road at discharges greater than about 500 cfs (somewhere between the 5-year and 10-year flow events). Under proposed conditions, the county road will overtop between the 50-year and 100-year flows. This conveyance capacity exceeds the 10-year capacity stipulated by American Association of State Highway and Transportation Officials (AASHTO) guidelines (as modified by the Montana Department of Transportation) for roads of this type. The change in backwater characteristics due to this change in culvert conveyance will aid natural sediment transport through the site at low flows and minor high flows, and will significantly reduce the potential for road crossing washout at flows less than the 50-year flow.

Culvert Cutoff/Headwalls

Headwalls were added to the entrance and exit of each culvert to increase inlet efficiency, prevent uplift of the culvert lip, and prevent seepage flows from eroding soil around the pipe (a condition evident in the existing culvert emplacement). The walls are cast-in-place concrete and extend to a depth of 3 feet below the culvert invert, 4 feet beyond the sides of the culvert, and 1 foot above the culvert crown. Headwall, bedding, and other culvert installation details are shown on Sheet I26.

TABLE 3.9-1
ESTIMATED BACKWATER ELEVATIONS FOR EXISTING AND PROPOSED CULVERT ROAD CROSSINGS
Reach A (Subarea 1) - SSTOU Remedial Design

Return Period	Existing Backwater Elevation (feet)	Proposed Backwater Elevation (feet)	Difference (feet)
5-year (440 cfs)	5408.3	5404.5	-3.8
10-year (610 cfs)	5410.5	5405.4	-5.1
20-year (780 cfs)	5410.5	5406.3	-4.2
50-year (1042 cfs)	5410.5	5407.6	-2.9
100-year (2330 cfs)	5411.5	5411.7	+0.2

Note: Water Surface Elevations are located immediately upstream of the county road crossing

Embankment and Road Approaches

The existing embankment has a road bed elevation that dips as low as 5409 feet and averages approximately 5410 feet. The proposed road grade runs horizontal at an elevation of 5409.5 feet in the vicinity of the channel culvert. The road climbs at a 3.8% grade to an elevation of 5412 feet, which is maintained in the vicinity of the diversion channel culvert. This road prism will allow for adequate cover over both culverts and will maintain overtopping flows at a uniform depth. The embankment height of the new installation roughly corresponds to existing road elevations to reduce the quantity of fill material required. The alignment of the road approaches have not been altered. In areas where the existing road surface is destroyed, it will be replaced with an aggregate surface meeting MDT specifications for roads of its type.

Embankment construction will require placement of fill compacted to 95% in 6-inch lifts. The culverts will be bedded on a minimum of 6 inches of granular fill. If existing material is found to be unsuitable as bedding, material will be imported for this purpose. The trench for culvert placement will be cut a minimum of 18 feet wide, with at least 3 feet clearance on each side of the culvert to allow for its assembly and for adequate compaction adjacent to the pipe during installation. Backfill material within 3 feet of the culvert walls will be compacted to 95% in 6-inch lifts.

3.9.4.3 Diversion Channel Culvert

Headwall and installation details for the reconstructed channel culvert and the diversion channel culvert are identical, the only difference being the elevations at which the culverts lie.

3.10 BORROW AREA

Floodplain backfill for Reach A and the MWRR 2 cap will require approximately 85,500 bcy and 15,300 bcy of borrow respectively. The required borrow will be excavated from Borrow Area 10 (BA-10). The general site map, Sheet M3, shows the borrow area location. Based on investigations conducted for the Remedial Design (ARCO, 1997c), an estimated 182,500 bcy of suitable borrow material is available from BA-10. The

suitability of the borrow is based on criteria for physicochemical characteristics which were identified in the Comprehensive Remedial Design Work Plan (ARCO, 1997a).

3.10.1 Objectives

The primary objective for borrow is to provide suitable backfill materials and growth media for the reconstruction of the floodplain and the MWRR cap. The ROD states: "Replacement fill will be required in most locations where tailings/impacted soils are removed. Replacement fill and streambank reconstruction with suitable growth media having an appropriate texture and particle size distribution will be required." Suitability was defined in the Comprehensive Remedial Design Work Plan through criteria for borrow materials for several physicochemical parameters. According to the Comprehensive Remedial Design Work Plan, "General fill material is distinguished from materials that will be in the final root zone."

Secondary objectives identified in the Comprehensive Remedial Design Work Plan for locating and obtaining borrow include:

- "An effort will be made to locate additional borrow areas where erosion and surface water runoff would have minimal effects on long-term post-construction borrow area topography";
- "All borrow areas will be engineered so that the post-construction topography of the area will blend naturally with the surrounding topography and will not affect the present floodplain"; and
- "Reclamation of disturbed borrow areas will include grading of the area to match post-construction topography consistent with the final land use of the area. A reclamation plan will be developed which describes all aspects of the reclamation of these borrow areas as stipulated by the [State mine reclamation ARARs identified on pages A-25 through A-28 of the ROD]".

3.10.2 Design Criteria

Design criteria for backfill can be divided into suitability and excavation criteria. Suitability criteria address the quality of the borrow and excavation criteria address the manner in which the borrow area will be opened and reclaimed.

3.10.2.1 Suitability Criteria

Borrow materials for floodplain backfill must meet requirements for general backfill (material below 18 inches of the final regraded surface) or root zone (vegetation) backfill for material in the upper 18 inches of the final regraded surface (Table 3.10-1). Potential borrow areas were characterized through excavation soil test pits at a minimum frequency of one pit per acre, sampled and analyzed as specified in Supplementary Studies Work Plan for Floodplain Backfill Investigation (ARCO, 1996). Additional pits were excavated where dictated by soil textural or chemical heterogeneity.

3.10.2.2 Excavation and Reclamation Criteria

To comply with the objectives concerning erosion and reclamation in the Comprehensive Remedial Design Work Plan for the development of the borrow areas, the following criteria must be met in the borrow area design and construction:

- Strip and stockpile the top six inches of topsoil;

- Maintain a maximum 2H:1V slope during construction;
- Recontour side slopes to a maximum of 4H:1V at reclamation;
- Maintain existing drainage ways and promote positive drainage; and
- Reclaim borrow areas as stipulated by reclamation ARARs identified in the ROD.

TABLE 3.10-1
SUITABILITY CRITERIA FOR FLOODPLAIN BACKFILL MATERIALS
Reach A (Subarea 1) - SSTOU Remedial Design

Parameter	Suitability Criteria
Soil Textural Classes (≤ 2 millimeters)	Cannot be sand, clay, or loamy sand (U.S. Dept. of Agriculture textural triangle classification)
Rock Fragments	< 35% on volume basis for root zone (0-18 inches) < 60% on a volume basis for general fill
Saturation Percentage	> 25% and < 85%
pH	> 5.5 and < 8.5 standard units
Electrical Conductivity	< 4000 µmhos/cm for root zone materials < 6000 µmhos/cm for general fill
Sodium Adsorption Ratio	< 12 for root zone materials < 20 for general materials
Element Arsenic Cadmium Copper Lead Mercury Zinc	*Total Concentration (milligrams per kilogram)* < 30 < 4 < 100 < 100 < 5 < 250

3.10.3 Supporting Data

Twenty-four individual potential borrow areas were investigated for Subarea 1 by ARCO, with approximately 426 samples submitted for analyses from a total of 161 soil pits (ARCO, 1997c). Six of the potential borrow areas (Sites 1, 2, 8, 10, 12, and 17) met the suitability criteria (RRU, 1997c). The IDR for Subarea I contains data for all borrow areas except Borrow Area 17. The field investigation for this borrow area was not completed before the IDR was issued.

In general, surficial contamination is present at all borrow areas proposed for use. The contamination is manifested in elevated metal and arsenic concentrations and/or low pH values. Stripping the top six inches of soil will eliminate the soils exhibiting metal /arsenic concentrations in excess of suitable borrow criteria.

Based on further analyses by the Agency design team, the following borrow areas were eliminated from consideration for use in Reach A:

1. Field reconnaissance revealed that the eastern one-third of BA-2, as outlined in the IDR, consisted of bedrock outcrops. The outcrops, a utility pole in the middle of BA-2, and steep slopes resulted in halving the borrow volume estimate to approximately 4,000 cy. The logistics of crossing a rail line, constructing a ramp to an embankment, and crossing a county road made the cost of utilizing this relatively small volume of borrow excessively high.

2. Borrow Area 12, located approximately three miles from the upstream end of the SSTOU and within a Butte neighborhood zoned as one-family residential, was also eliminated as a source of borrow. Aside from the disadvantages of using this source of borrow due to hauling on public roads and local government concerns, a considerable portion of the borrow area, as shown in the IDR, was located in residential backyards and a wetlands area.

3. Both BA-8 and BA-17 would require longer hauls to Reach A when compared to the haul distance from BA-10. BA-8 has less suitable texture for uplands. Therefore, BA-8 and BA-17 will not be used as borrow sources for Reach A but are potential sources of borrow for other reaches in Subarea 1.

4. ARCO reserved the right to use the land at BA-1 for other purposes in the future, thus it is unavailable for borrow.

Therefore, BA-10 will be the only borrow source for Reach A floodplain construction. RRU estimated that approximately 182,500 bcy of suitable borrow are available from BA-10 (RRU, 1997c). These are rough estimates since the test pit locations are approximated and the average end area method was used to calculate volume.

In-place density testing was performed at BA-10 during the Remedial Design (Maxim, et. al., 1998). Several densities were taken within the borrow area to obtain representative values. The in-place densities were compared with the anticipated backfill densities after compaction in order to determine the actual borrow volume needed. Table 3.10-2 shows average in-place densities for BA-10 and volume conversions. Since the estimated volume required for floodplain backfill in Reach A and the soil cap for MWRR 2 is 99,900 bcy (taking differing densities into account this equivalent to 101,000 bcy in BA-10, as shown on Table 3.10-2) a sufficient volume of borrow is available from BA-10 for Reach A construction.

3.10.4 Design Components

Only as much borrow as is necessary for reclamation of Reach A and MWRR 2 will be removed from BA-10. This should be taken into consideration by the construction contractor in planning the excavation of BA-10 with respect to clearing, grubbing, and revegetation since the borrow quantities required will be considerably less than the available material. In order to minimize surface disturbance, excavations are to be to the final excavation surface, as shown on the drawings. It is recommended that borrow excavation start on the east side of the borrow area and progress to the west until the Reach A quantity requirements are met. Remaining BA-10 material will be used on subsequent RA construction in Subarea 1.

TABLE 3.10-2
IN-PLACE DENSITIES AND BORROW VOLUME REQUIRED
Reach A (Subarea 1) - SSTOU Remedial Design

Borrow Area	Average In-Place Density (lbs/cf)	Maximum Density (lbs/cf)	Borrow Placement Location	Placed Volume (cy)	Placement Compaction Required (% Max.)	Minimum Placement Density (lbs/cf)	Borrow Required/ Available (bcy)
10	89.1	100	Floodplain and Haul Road Crossings	84,600	90	90	85,500
10	89.1	100	MWRR Cap	15,300	90	90	15,500
						TOTAL BORROW VOLUME REQUIRED:	**101,000**

Notes: In-place density and moisture-density lab data presented in Appendix I.
lbs/cf = pounds per cubic foot; cy = cubic yards; bcy = bank cubic yards

Initial staking of the borrow area limits and clearing and grubbing in the borrow area shall be limited to the area detailed on Sheet M8. Field adjustments or changes to the borrow area limits may be determined by the Owner's representative. After the borrow area is cleared and grubbed, the top six inches of topsoil will be stockpiled for reclamation purposes.

Once the topsoil is stockpiled, the borrow material shall be excavated to the elevations shown on Sheet M8. The final excavation surface will have slopes no steeper than 4H:1V. The RA construction contractor shall implement an excavation approach that limits ponding of surface water and erosion. Excavation cut faces where equipment is not working shall be immediately sloped back to a 2H:1V slope or less. Sideslopes will be monitored for stability and potential safety concerns.

There will likely remain small zones within each characterized borrow area that do not meet all of the required criteria and that were not delineated by the sampling density employed. If these zones are sufficiently small that mixing during excavation produces material meeting the criteria, no attempt will be made to segregate these zones. If zones are encountered where mixing will not be sufficient to allow compliance with criteria, the materials will not be used. Borrow material will be excavated and tested as defined in the Construction Quality Assurance Plan (CQAP). This plan requires that a continuous field evaluation be conducted during excavation to insure backfill meets specifications. The Owner's Representative will determine the suitability of all material. The CQAP includes a minimum sampling rate of one sample per 5,000 bcy or any time a visual change occurs in the material being excavated. Samples will be analyzed in the field by the Owner's Representative to determine percent rock content, soil texture, pH, and electrical conductivity. In addition, hand texturing and pH will be determined on a continuous basis during excavation.

The Owner's Representative will survey the borrow area to control the excavation to the lines and grades presented on the plan sheets.

Final regrading of the borrow area will be performed as necessary to provide positive drainage and to match the surrounding topography. The Owner's representative will perform the final survey to identify final grading requirements or verify that grading is appropriate. The final surface needs to be ripped and then evenly

covered with topsoil from the stockpiles which will be utilized for the seedbed. Section 3.12 provides the details for revegetation.

3.11 FLOODPLAIN RECONSTRUCTION

Floodplain reconstruction is needed to restore a functioning stream and floodplain system after removal of tailings/impacted soils. In order to reconstruct the floodplain, the excavated surface will be further excavated in a few places, borrow material will be imported and graded, and the floodplain will be revegetated. Prior to revegetation, the reconstructed floodplain will be contoured to accommodate future placement of a recreational trail at the alignment specified by the Greenway Service District (see Section 3.14.6). This section describes the design for the reconstructed floodplain. Revegetation is addressed in Section 3.12.

3.11.1 Objectives

Floodplain reconstruction following removal of tailings/impacted soils from Reach A Creek is designed to be consistent with the objectives set forth in the ROD (MDEQ and EPA, 1995) and Comprehensive Remedial Design Work Plan (ARCO, 1997a). The ROD states that, following removal of contaminated materials from the floodplain, "the overall topography of the replacement fill material will be appropriately sloped toward the stream channel, with the goal of creating geomorphic stability." (p. DEC-3). The primary objective of floodplain reconstruction, therefore, is to promote geomorphic stability in conjunction with stream channel design. Floodplain reconstruction designs were also conducted within the criteria set forth in the Floodplain Management Order, as reported in the Comprehensive Remedial Design Work Plan.

3.11.2 Design Criteria

The development and justification for design criteria developed for floodplain reconstruction are reported in the *Conceptual Design Report* (Inter-Fluve and MEI, 1998). Design criteria were developed to promote geomorphic stability, to reduce the potential for channel avulsion, to provide drainage from the floodplain to the channel, and to provide topographic and vegetative diversity. The primary design component used to reduce the potential for avulsion are overbank terraces. Specific design criteria relevant to Reach A of Subarea 1 are listed below:

- Floodplain surface elevations will in all cases have a minimum elevation that is equal to or greater than the top of banks, unless standing water wetland areas are incorporated;
- Where potential cost savings for floodplain backfill can be achieved through modification of channel geometry or channel grade and still meet all channel and bank design criteria, these floodplain modifications will be cooperatively designed with the input and approval of other firms and agencies;
- Floodplain surfaces will have a minimum slope of 1 percent towards the channel banks;
- Overbank terraces will be designed to contain a minimum of the 5-year flow at their crest surface elevation;
- Terrace design will minimize the need for additional fill, except where essential to reduce the risk of avulsion;
- Wetland depressions will be incorporated in the remediated floodplain. Wetland depressions will be located in areas of the floodplain that will not have an impact on channel or overbank hydraulics;

- Floodplain and terrace design will be integrated to eliminate areas where groundwater elevations exceed floodplain elevations to the extent that the data necessary to conduct these designs are available during the design process. If wetland environments are required, these will take precedence and will be an exception to these criteria; and

- Terrace design will not have an impact on in-channel hydraulics such that it requires modifications to channel or bank design. In other words, channel and bank design will take precedence, and terraces shall not appreciably affect their design.

Based on tailings removal maps developed by Maxim, downstream from the I-90/15 bridges, 100 percent of the surface area of the floodplain to the horizontal limits of tailings/impacted soils will be excavated. This extent of removal essentially provides for a great deal of freedom in floodplain reconstruction design. Designs for the lower section of Reach A included consideration for reducing the volume of borrow and backfill required to reconstruct the floodplain relative to the volume of materials excavated as waste material. Minimizing borrow and backfill requirements will reduce total project costs. In the upstream section of Reach A between the Interstate bridges, the floodplain will be reconstructed to the limits of the horizontal extent of tailings along the right (north) bank. Along the left (south) bank, there is no floodplain under existing conditions. Channel designs will allow for a truncated floodplain, less than 10 feet in width, which is tied into the steep slope of existing topography.

3.11.3 Supporting Data

Inter-Fluve and MEI developed the reconstructed floodplain based on the design criteria listed above. The reconstructed floodplain surface was developed first in a cross-sectional form to facilitate surface water elevation modeling. Inter-Fluve modeled shear stress on the floodplain using HEC-RAS to determine velocities and depths of flow. Output from this computer modeling effort is found in Appendix H-2. After the modeling effort confirmed that shear stresses on the floodplain were not excessive, Inter-Fluve produced a one-foot contour map of the final floodplain topography.

Maxim was tasked with developing the borrow volume required to backfill the floodplain to the final contours. To do this, Maxim used the tailings/impacted soil excavation surface and the final grade to identify areas of cut and fill and their respective volumes. The excavation surface had been developed on a 50-foot grid as part of the tailings/impacted soil excavation (Section 3.3). A final grade surface was developed on the same 50-foot grid by interpolating elevations from the contour map supplied by Inter-Fluve and the volume was calculated from the difference of elevations on the grid.

Because the reconstructed floodplain was generally lower than the original ground surface and in some places lower than the excavated surface, little or no backfill would be imported in some areas. If the existing soil was of unsuitable quality for the root zone, there was a concern that revegetation of those portions of the floodplain would fail. Therefore, the Natural Resource Information System (NRIS) conducted an analysis to determine if such areas of unsuitable texture were present. Using a three-dimensional database of soil textures developed by Maxim (1998c) from the hand textures taken by ARCO during test pit investigations, NRIS determined the existing soil texture for areas with less than six inches of cover. The map showing the results of this analysis is included in Appendix J as Figure J-1. The result of this analysis was that there were minimal areas of unsuitable soil texture (i.e. loamy sands or sands) in these sensitive locations. Of the two small areas with potential texture problems, one was in a wetland situation and would have sufficient moisture to promote vegetation. The second area consisted of loamy sand in wetland and transitional zones. Again, the presence of groundwater indicated that vegetation could be successfully reestablished in spite of the inappropriate textures. Therefore, no modifications to the final topography were made.

Additional design data and design memoranda to support designs described herein are provided in Appendix H-2.

3.11.4 Design Components

Designs for floodplain reconstruction of the lower section of Reach A of Subarea 1 include the following components: 1) reconfigured floodplain topography; 2) terraces; and 3) wetlands. Soils selection, including appropriate borrow for floodplain backfill materials and surface growth media, and floodplain vegetation design are reported in other sections of this document. Soils selection and revegetation of the floodplain will be an integral component of remediation and long-term stability of the floodplain. Revegetation designs for the floodplain and wetlands are discussed in Section 3.12 and further detailed in Appendix J.

The reconfigured floodplain consists of a relatively constant slope (one percent) from the top of channel banks to the edge of extent of tailings removal excavation (Sheets I3-I6). This slope provides for positive drainage toward the channel from precipitation and snowmelt. Additionally, it acts to distribute overbank flow energy. A steeper floodplain slope will concentrate overbank flows on the channel and near-channel margins, rather than allowing for distribution of energy. The highest shear stresses on the floodplain surface range from 0.24 lbs/ft^2 at the 5-year flow to 0.52 lbs/ft^2 at the 50-year flow. High shear stresses were all found to be associated with areas where the narrowing of the floodplain constricted overbank flows (i.e., at stations 16+00, 42+00, and 55+00).

The reconfigured floodplain also results in a substantial reduction in backfill required as compared to reconstruction of a floodplain to existing topography. Excavation and removal of tailings/impacted soils will result in the export of 174,000 cubic yards of waste material. Reconstruction of the floodplain to the design topography will require 98,200 cubic yards of backfill. However, 20,500 cubic yards of this required backfill can be obtained from areas where reconstruction of the floodplain will require excavation beyond the tailings/impacted soils excavation surface. Consequently, the amount of borrow material required to reconstruct the floodplain to the design topography is reduced from 98,200 to 77,700 cubic yards.

Where the reconstructed floodplain slope would not tie into the existing topography at the design 1 percent slope, a 4H:1V slope was incorporated to tie the reconstructed surface in to the existing surface beyond the extent of tailings removal. It is anticipated that some degree of variability in this 4H:1V slope will be incorporated as adjustments are made in the field during the Remedial Action.

The reconstructed floodplain topography is shown on Sheet I1 of the drawings. Sheets M5a-e present final topography elevations to be staked in the field. The final staking plan has supplemental points that are not in the excavation staking plan. These are the following:

1. Points that were in the original channel were not included in the excavation staking plan. Points that were in the original channel but are not in the final channel were included in the final grade staking plan.

2. In order to define the break between the 1 percent slope and the 4H:1V slope accurately, points were added to define this break where needed.

Reach A of Subarea 1 includes four terraces that are topographic high points in the floodplain topography (Sheets I2-I6). Terraces are designed to prevent overbank flow from cutting between meander bends and resulting in channel avulsion by concentrating the flow during higher flow events in the channel rather than on the floodplain. While floodplain surface shear stresses modeled without terraces, even at the 50-year flow, were insufficient to jeopardize floodplain grasses, terraces were incorporated as an additional measure of

protection. Details of the floodplain surface hydraulics are provided in a technical memorandum in Appendix H. Additional protection from avulsion results from a floodplain and channel design which result in bankfull conditions occurring simultaneously at all points along the stream channel. In this case, overbank flow occurs simultaneously at all channel margins. This ensures that overbank flows will not drop back into the channel creating the potential for a nick point through a channel bank.

Wetland depressions are located in areas of the floodplain that will not have an impact on channel or overbank hydraulics. Wetland depressions are located largely in association with terraces such that materials excavated from wetland depressions may provide for terrace fill requirements. Wetlands are shown on Sheets I-3 to I-6. Revegetation of the wetlands will be conducted after initial RA construction of Reach A.

The proposed Greenway Trail ultimately will be constructed on the surface of the reconstructed floodplain. The planned trail alignment and design will generally follow the final floodplain topography and will not have an impact on channel and overbank hydraulics. Several diversion channel crossings and one stream crossing are planned for the Greenway Trail along Reach A, but construction of the crossings will be the responsibility of the Greenway Service District and they will not be part of the initial RA construction contract. Section 3.14.6 contains a more detailed description of the Greenway Trail.

3.12 REVEGETATION

Successful revegetation requires two major processes: primary productivity and decomposition. Revegetation planning for the SST OU focuses on matching plant species to habitats, identifying practices that will establish those species, assuring plant nutrition and nutrient cycling, limiting weed invasion and abundance, and anticipating temporal developments. This section covers revegetation objectives, regulatory concerns, and supporting data. Design components are outlined. Details of revegetation strategies, such as substrate treatments, planting prescriptions and practices, and weed control measures, are covered in Appendix J. That appendix also explains how hydrologic regimes and coversoil classes were derived and applied and discusses nutrient cycling in relation to revegetation strategies.

3.12.1 Objectives

The Comprehensive Remedial Design Work Plan specifies that the Remedial Design will identify and address major technical components such as revegetation areas and methods (Comprehensive Remedial Design Work Plan, p. 43). Objectives include establishing a diverse, effective, and permanent vegetative cover on all reclaimed areas (p. 45) and attainment of all reclamation/revegetation ARARs. Vegetation also will be used for streambank stabilization and aesthetic enhancement (p. 61). A map set indicating the location of revegetated plant communities must be part of the design information (p. 51). The design must identify planting zones for particular plant species based on their tolerance to inundation and desiccation (p. 78). Plants selected for revegetation will include those capable not only of establishing but also of persisting and regenerating to provide effective vegetation cover in both short and long terms (p. 64).

Special values for particular areas may influence revegetation planning. Wetlands are a case in point. Of the 11 commonly accepted functional values listed by Hammer (1997), the primary ones for the SST OU are wetland replacement (mitigation), since these are required by law and executive order, and recreational, because the ROD anticipates that the area will be developed into a recreational corridor.

3.12.2 Design Criteria

3.12.2.1 Hydrologic Component of Revegetation Habitat Types

One precept of revegetation planning is that propagated species be matched to appropriate habitats. Revegetation habitat types have been defined on the combined basis of hydrologic regime and soil texture. Hydrologic zones are defined and discussed in Appendix J. Four hydrologic zones have been identified for Reach A:

1. Wetlands, conforming to jurisdictional definition and further divided into inundated and saturated wetlands.

2. Transition Zone, where the upper soil usually is aerated, but occasionally saturated or inundated.

3. Subirrigated Zone, where groundwater is available only to deep-rooting species.

4. Upland Zone, where groundwater is unavailable to plants under normal circumstances.

3.12.2.2 Soil Component of Revegetation Habitat Types

The second important habitat component is soil, if present, or coversoil material serving as soil. Soils, to use that term broadly to include coversoils originating as deep borrow material and in situ substrates remaining after tailings/impacted soils have been removed, have been placed into three classes:

1. Coarse soils suitable for revegetation in wetlands and the transition zone, but poorly suited to uplands due to rapid drying, low water-holding capacity, and low cation exchange capacity (CEC). Class 1 soils include most of the upland area on the north side of the floodplain and other in-situ soils where texture is loamy sand or a coarser textural class.

2. Class 2 soils consist of finer-textured soils from Borrow Area 10 (sandy loams with about 10% clay) and in situ soils of sandy loam and silty loam texture. These soils are suitable in any hydrologic zone.

3. Class 3 soils consist of in situ soils with indicated texture of silty clay loam and clay loam. These soils too are suitable for any hydrologic zone.

Revegetation planning requires defining and mapping important soil/substrate classes. "Practical" soil/coversoil classes should have these characteristics to be useful in revegetation planning:

1. These materials must be uniform from a practical perspective. Classes must differ significantly in properties related to plant performance and their suitability for different species. Obvious examples would be moisture- and nutrient-holding capacity, presence and abundance of important soil organisms, and depth to textural discontinuity.

2. Classes must be located in the backfilled floodplain in a way that comprises useful units for revegetation planning and planting. Each class must contain enough material so that an appreciable acreage, i.e., approximately one acre, is present in a segment of the backfilled floodplain.

From a revegetation standpoint, the main limitations of soils/coversoils suitable for Subarea 1 revegetation are textural and biological. All coversoils originating as deep borrow materials will lack important soil

organisms, so this is not a differentiating criterion but rather a condition requiring special strategies for all coversoils that were not previously topsoil. This topic is discussed in Appendix J.

3.12.2.3 ARARs

Design criteria for revegetation also are guided by ARARs (Comprehensive Remedial Design Work Plan pp. 116-117) which state that there must be an approved revegetation plan. Near-surface soils or soil substitutes must be at least as capable as soil in supporting the approved vegetation, and must be the best available in the area to support vegetation. Plant cover and stocking of trees and shrubs must be adequate to achieve the approved post-reclamation land use. Seeding must occur in the first appropriate period following seedbed preparation. Revegetation must comply with an approved reclamation plan. Revegetation must be able to regenerate under the natural conditions prevailing at the site. Revegetation will be permanent, diverse, predominantly native, and of the same seasonality and utility found in similar predisturbance areas. Deleterious competition between different growth-forms must be avoided. Seeding will be calculated on a pure live seed basis with documented germination percentages. There must be an approved noxious weed plan. Introduced species should be in the minority and must be as capable as native species in meeting other requirements. The agencies shall determine cover, planting, and stocking specification based on local and regional conditions.

Also, reclamation of borrow areas must conform to reclamation ARARs identified in the ROD (Comprehensive Remedial Design Work Plan p. 59). All available topsoil must be stripped, stockpiled, and safely stored apart from overburden. The reclamation plan must specify that enough soil material will be salvaged to provide a minimum 18 inches of reclaimed soil material thickness (if available) on dryland range, pasture, etc. in the reclaimed landscape. If the soil stockpile or any overburden stockpile will remain undisturbed for more than one year, it must be seeded at the first appropriate opportunity with the permanent seed mix. A cover crop must be seeded on any area that will go through a complete growing season without first being seeded to the permanent mix. Appropriate measures must prevent deterioration of water quality or quantity and prevent erosion resulting from roads. Following mining, the ground surface must be capable of supporting the post-mining land use, must be at least three feet above the seasonal water table in uplands, must blend into the surrounding topography, drain or concentrate water as appropriate, and meet certain slope restrictions. All material not conducive to plant growth must be buried under at least three feet of material suitable for plant growth. Ripping of compacted areas is required. Stockpiled coversoil will be reapplied and a vegetative cover capable of sustaining the post-mining land use will be established.

3.12.3 Supporting Data

3.12.3.1 Soils

Textural classifications of suitable borrow area materials were summarized in a technical memorandum prepared by the Reclamation Research Unit (1997d) based on information in the IDR. Soil textures for the excavated floodplain were mapped by NRIS using information provided by Maxim Technologies (1998c). An accompanying memorandum described data sources and methods. Three samples of substrates below tailings/impacted soils were analyzed for fertility and organic matter by Maxim Technologies.

Samples of borrow area coversoils, deep borrow materials, and three commercial compost samples were analyzed for fertility and organic matter at the MSU Soil Laboratory. Portions of the same set of samples were submitted to Soil Foodweb Inc. (Corvallis, OR) for quantification of active bacterial biomass, total bacterial biomass, active fungal biomass, total fungal biomass, protozoa numbers, nematode numbers and community structure, and VAM spores (vesicular-arbuscular mycorrhizae, discussed in Appendix J). This information has been summarized in a memo (Prodgers 1998c). Results indicate that bacterial biomass is

low but can reestablish when food sources become available. Decomposer fungal biomass and mycorrhizal fungi are very low. Protozoa are virtually lacking.

The soil class map used for revegetation planning is Figure J2.

3.12.3.2 Hydrology

Montana Bureau of Mines and Geology (Abdo, 1998b, pers. comm.) constructed a map indicating projected groundwater elevations based primarily on the surface water elevation in Silver Bow Creek (as reconstructed, Inter-Fluve and Mussetter, 1998) when carrying 30 cfs and a surface water elevation in the diversion ditch one foot above the ditch bottom. These surface water elevations were chosen to approximate hydrology during the spring portion of the growing season when surface water conditions were above base flow (about 20 cfs). Groundwater control was approximated by adding one foot to groundwater elevations measured in September 1997 in wells located farthest from the creek. The one-foot differential was estimated from the groundwater elevation fluctuation during the growing season at Demonstration Project 1. These groundwater elevations approximate the wetter periods of the growing season. Groundwater elevations were slightly lower in 1997 than in 1994 and 1995.

Delineations of hydrologic zones (depth increments to groundwater) were made by combining a topographic map (Inter-Fluve reconstructed floodplain topography) with the groundwater contour map described above. The important hydrologic zones (wetland, transition, subirrigated, and upland) were mapped in this manner. Prior to revegetation, depth to groundwater will be confirmed and the revegetation map will be modified where necessary to correspond to actual depths to groundwater.

The diversion channel will change the pattern of hydrologic zones within the floodplain. The existing hydrology (i.e., with the diversion channel) will dictate the revegetation plan. At the same time, the anticipated hydrologic pattern without the diversion channel was considered in locating herbaceous plug and woody plantings to minimize the amount that are likely to perish when the diversion channel is removed.

3.12.3.3 Vegetation and Revegetation

In addition to fundamentals, revegetation of uplands incorporates specific lessons learned from Butte Priority Soils revegetation (Prodgers, 1999,1996a; 1996b; 1995; 1994), including monitoring of the Texas Avenue test plots 15 years following revegetation (Prodgers, 1998a).

In the wetter zones, our approach followed Hammer's advice (1997), "The best guidelines for selecting plant species for new wetlands will come from observing a similar wetland in the vicinity." More than 250 vascular plant species have been identified along the SST OU (Prodgers, 1998b), compared to a previous effort that yielded 83 taxa, some of them incorrect (EAEST, 1994). Important information for matching revegetation choices to plant habitats came from investigations of plant communities, soils, and hydrologic regimes along Silver Bow Creek and nearby environs in summer 1997. These were undertaken jointly by Natural Resources Conservation Service (NRCS, Whitehall Office) and Bighorn Environmental. Plant communities were sampled for canopy coverage (Daubenmire, 1959). Soils were sampled and described using Order II Soil Survey methods. The cover of important species was ordinated relative to texture/particle size classes and hydrologic regime. Also sampled were dissolved oxygen concentration, pH, and EC of groundwater, when present within five feet of the ground surface.

Revegetation prescriptions were devised and/or modified at a two-day meeting of soil scientists and plant material specialists from the NRCS, mine reclamators and regulators, and independent plant ecologists. Soil microbiologists were later consulted about plant nutrition and nutrient cycling aspects of revegetation planning

(St. John, 1997-98, pers. comm.; Ingham, 1997-98, pers. comm). These collaborative efforts brought to revegetation planning a broad array of concerns and informed viewpoints. Final prescriptions for uplands and the subirrigated zone were reviewed with Holzworth (1998, pers. comm.); wetland and transition zone prescriptions were reviewed with Hoag (1998, pers. comm.). Ultimately, Bighorn Environmental made the revegetation prescriptions.

3.12.4 Design Components

Design components which provide detailed revegetation strategies and practices that will govern revegetation are in Appendix J, whereas the most important factors are outlined here. Sheets J-1A and B show where the different revegetation prescriptions will be applied.

Cultivating a good seedbed includes plowing, chisel plowing, discing, fertilizing according to inherent and target nutrient concentrations, mulching, seeding, and ripping compacted substrates. The three basic nitrogen fertilizing options (nitrogen fixation, incremental mineral fertilizer application, and compost addition) will be used as appropriate in different revegetation strategies (Appendix J). The main use of compost will be in the repository coversoil. In the drier hydrologic zones, the fungal partner of vesicular-arbuscular mycorrhizae (VAM) will be incorporated into the seedbed during discing or fertilizing.

To a large degree, revegetation strategies are based on matching plants to appropriate habitats. Our studies of existing plants and environments guided these assessments. In prescribing a seed mix for a given type of habitat, one also must consider how the species will interact in both the establishment phase and in the long term, and how they will interact with other plantings (e.g., shrubs and trees).

In revegetating the floodplain, a mix of propagules will be introduced once and simultaneously in an agronomic setting. This is unlike anything in nature, where propagules are more or less constantly introduced in the fullness of time. In nature, when an unsuitable species (in the long run) becomes temporarily established, then perishes, propagules of more suitable species are present to colonize the site. Of course, this is a dynamic process, and which species are "adapted" in a fluvial environment changes through time.

When a seed mix is applied to a vacant substrate, long-term suitability is not the operative selective force. Establishment characteristics of the chosen species starts the race for resources, and the race goes to the quick. Species that germinate early and exhibit good seedling vigor are the ones to establish. Whether these same species will later drown or desiccate has no bearing on the establishment dynamic. Therefore, one must know not only which species are suited for a site, but also how the establishment dynamic will unfold for the chosen mix, which is further influenced by the total and relative rates of application of each species. The greater the number of inappropriate propagules deliberately introduced, the less likely long-term success becomes. Planting a few adapted species into a narrowly defined habitat allows temporal developments to be incorporated into propagule selections and application rates. Table 3.12-1 summarizes seeding and planting acreages.

Few species start and finish strong, so frequently one must balance strong establishers that provide erosion protection initially with long-lived species that endure on the site. A concrete but simple example of temporal considerations in revegetation planning is provided by the repository, where utilizing soil moisture so that it doesn't percolate into and through contaminated materials joins the usual revegetation concerns. Four factors are important: 1) full occupancy of the site by plants, 2) nitrogen availability, 3) a range of timings of maximum photosynthesis, and 4) complementary root depths. The cap will be Class 2 soil material. The seed mix follows:

2 lbs./A Pryor *Agropyron trachycaulum*
3 lbs./A Covar *Festuca ovina*
1 lb./A *Poa compressa*
2 lbs./A Ladak *Medicago sativa*

All four species in the seed mix are easily established in a firm seedbed and are well-suited to sandy loams and loams. Alfalfa develops later in the growing season than cool-season grasses and roots deeper than grasses. Sheep fescue is arguably the most successful revegetation grass in the Butte area and has weed-excluding abilities once well established. Canada bluegrass is well-adapted to contaminated and noncontaminated sites around Butte, responds well to fertilizer, and as a rhizomatous grass complements sheep fescue. Slender wheatgrass is included because sheep fescue establishes rather slowly, and slender wheatgrass establishes strongly but doesn't persist in uplands. Alfalfa is another strong establisher. This seed mix contains native and introduced species.

Nitrogen fertilization of prairie species leads to more rapid soil moisture depletion. In the repository prescription, alfalfa/*Rhizobium* provide nitrogen fixation which is superior to mineral fertilization. Citing four authors, Ryerson and Taylor (1974) concluded that higher efficiency of soil moisture use and moisture withdrawal to greater depth usually prevent nitrogen leaching through the soil profile in the 10-14-inch precipitation zone. Unless recharged by fall rains, fertilized plots in eastern Montana rangelands entered the winter with considerably lower soil moisture content than nonfertilized plots, indicating that nitrogen fertilization can increase the amount of precipitation that is used for plant growth. Yields indicated almost complete carry-over of unused N fertilizer from drought years (Wight, 1974), indicating minimal leaching of soluble nitrates. Where negatively charged nitrate ions don't leach, it is likely that very little water percolates through the rooting zone. A range of seasonality of plant growth and rooting depths also contributes to quick utilization of soil moisture throughout the growing season.

There is always the risk that alfalfa/*Rhizobium* either won't establish or persist. Our prescription for repositories calls for organic soil amendment (compost) because of the beneficial microbiological properties of good compost and also because compost provides reservoirs of carbon and nitrogen. VAM also are prescribed because they benefit desired species over weeds and also increase the uptake of nutrients and water.

The decomposition of dead plant material is a major restriction to nutrient mobility. Harrowing plant litter to put it in contact with soil, or in more extreme cases mowing and harrowing, may be beneficial when stands are a few years old. Incremental nitrogen fertilization also furthers decomposition as long as the rates are low and microorganisms appropriate to the energy substrate are present. A good compost provides a nutrient and carbon reservoir and also provides healthy levels of decomposers.

Few observers will think the Silver Bow Creek floodplain has been successfully revegetated if noxious weeds prevail. Riparian areas are especially susceptible to weed invasions. Exotic species can upset the ecological balance of communities and ultimately exert adverse impacts on naturally occurring biological diversity (Murphy, 1988). In our area, broad-leaved pepperwort, Canada thistle, marsh sow-thistle, and whitetop are likely candidates for moist soils. In the subirrigated and upland zones, two species of toadflax and leafy spurge are common, and spotted knapweed is all but ubiquitous. Weed management takes many forms in the revegetation plan.

Within the floodplain, planting substrates will initially be predominantly weed-free. Preventing the introduction of weeds into riparian areas has been called "critical to their management" (Shelley and others, 1995). Complete prevention is impossible, but delaying weed infestation is important. The earlier noxious weeds are introduced in the revegetation sequence, the more prevalent they will become because they will compete with desired seedlings rather than established plants. The contractor will be responsible for maintaining weed-free staging areas including equipment washing areas, and also chemical control of weeds along all access routes and portions of the floodplain adjacent to and within construction zones at least one year in advance of

TABLE 3.12-1
SUMMARY OF SEEDING AND PLANTING ACREAGES
Reach A (Subarea 1) - SSTOU Remedial Design[1]

Revegetation Zone	Plugs	Acre	Shrubs[2]	Acre	Trees	Acre	Seeding	Acre	Com-post	VAM (3)
Deep Water Wetland	Beaked, water, and Nebraska sedges.	0.10	--	--	--	--	Margins only; bulrushes and sedges	<0.1	No	No
Shallow Inundated Wetland	Beaked and water sedge, water smartweed, small-fruit bulrush.		--	--	--	--	Fowl bluegrass, smallfruit bulrush, Baltic rush, tufted hairgrass, American mannagrass, sedges, northern bluejoint.	2.1	No	No
Saturated Wetland	Baltic rush, silverweed, spike-rush, Nebraska sedge.	0.80	Booth's and Geyer's willows.	0.60	--	--	Fowl bluegrass, tufted hairgrass, Baltic rush, red fescue, 2 legumes.	11.6	No	No
Transition Zone	Baltic rush, clustered field sedge, Iris.	0.10	Booth's and Geyer's willows.		Aspen	0.10	tufted hairgrass, Baltic rush, meadow foxtail, legumes	10.8	No	Yes
Subirrigated	--	--	Sandbar willow, Bebb's willow with Wood's rose and golden current.	0.1 0.04	Cottonwood with snowberry	0.15	See upland/subirrigated below	--	--	--
Uplands/ Subirrigated - Class 2 and 3 Soils	--	--	--	--	--	--	Sheep fescue, thickspike wheatgrass, basin wildrye, Canada bluegrass, forbs, & legumes.	9.15	No	Yes
Shrub areas							Slender wheatgrass, lily of valley, bluejoint reedgrass, white clover.	0.15	No	Yes
Test							Russian wildrye and alfalfa	2.0	No	Yes
Uplands - weedy seed bank	--	--	--	--	--	--	Sheep fescue, basin wildrye, slender wheatgrass, Canada bluegrass.	47.7	No	Yes
Same, compost test							Same	2.0	Yes	Yes
Mine Waste Relocation Repository	--	--	--	--	--	--	Sheep fescue, Canada bluegrass, alfalfa, slender wheatgrass	7.5	Yes	Yes
Sediment Basin sides	--	--	--	--	--	--	Crested wheatgrass, alfalfa, Canada bluegrass	3.0	No	No
Sediment Basin bottom	--	--	--	--	--	--	Smooth brome, birdsfoot trefoil	0.5	No	No
Total Acreages	**Plugs**	**1.00**	**Shrubs**	**0.74**	**Trees**	**0.25**	**Seedings**	**96.6**	**9.5**	**82.8**

Notes: (1) - Acreage summary calculated from digitized areas by Montana Natural Resource Information System as shown on Sheet N1 - PFDR and additional repository, haul road, and staging area acreage provided by Maxim; total disturbed acreage 96.6 acres not including the stream.
(2) - Special seed mixes or light applications or the usual seed mixes will be used in shrub/tree planting areas.
(3) - VAM = vesicular-arbuscular mycorrhizae

construction. At repositories, weedy topsoil will be buried at least six inches below the final ground surface and at least one foot below the ground surface if organic amendment is prescribed.

Most upland sites, including borrow areas and sites that will be used as haul roads and staging areas, have weedy seed banks in the topsoil. Noxious weeds will establish with desirable species if not earlier. Seed mixes for these areas contain proven weed-restricting qualities, but they are not effective in the establishment phase. Consequently, these areas will require chemical weed control, probably in the second year and perhaps subsequently. No forbs, including legumes, will be planted in these areas.

Plant competition is another important component of weed control. The more fully desired species utilize resources, both spatially and temporally, the less likely infestation will develop. Where revegetation can be established with few noxious weeds, and where weeds are chemically controlled before they become abundant, plant competition by planted species is expected to limit weed abundance, particularly in the long run. Species that have been shown to dramatically limit weed abundance locally when successfully established include Russian wildrye, sheep fescue, basin wildrye, and alfalfa (Prodgers, 1998a).

In uplands, establishing persistent, relatively weed-free plant communities will be promoted if soil textures are no coarser than sandy loams with at least 10 percent clay content. Poor soils lead to impaired plant abundance. Unoccupied habitats then are colonized by weeds in more favorable years. We also count VAM inoculation among weed control measures. Most weeds have an abundance of root hairs which give them an advantage over may desirable perennials in nutrient uptake. Inoculating with VAM should give desired species a competitive boost in relation to weeds.

Where needed, compost has been selected rather than stockyard manure because manure brings with it the risk of putting weed seed into the seedbed, including weeds that are not normally problems in this portion of Butte-Silver Bow County. Two important weeds associated at Butte with manure treatments are cheatgrass and whitetop, the latter a mustard. In properly prepared compost, plant seeds are killed during thermophilic decomposition.

Despite all the measures discussed above, noxious weeds will establish sporadically in the floodplain. This means that herbicide application will be necessary, especially in the short run. Selective chemical weed control will be used to nip weed invasions until revegetation is well-established. Careful application of herbicides from backpack applicators should suffice where weed seed is not present at the inception. Only herbicides approved (on the label) for riparian areas can be used in wetlands, subirrigated sites, and the transition zone that bridges them. These include 2,4-D, fosamine, glyphosphate, and triclopyr. Other persistent or especially leachable herbicides can be used only where they will not reach water. Wick applications will further decrease the likelihood of groundwater contamination.

To an extent, infestation of noxious weeds indicates that resources such as soil moisture and nutrients are not being used efficiently some time during the growing season. Simply killing the weeds often leaves the site ripe for reinfestation because weeds are more adept at colonizing new habitats than desirable perennials reproducing from seed, and weed seed usually predominates in the soil seed bank even in nonweedy plant communities (Clark, 1991). Spot seeding and fertilizing will follow spot herbicide application.

Patterns of different physiognomic vegetation types contribute to the attractiveness of landscapes, linking diversity and aesthetic objectives. (In physiognomy, the emphasis rests on the appearance of vegetation, regardless of its floristic composition.) To the extent that this is achievable within the constraints of matching plants to habitats, controlling weeds, establishing nutrient cycling, etc., we have endeavored to establish a visually pleasing pattern of physiognomic vegetation types. Sedge-rush, grass, and grass-forb plant communities alternate with willows and golden currant in the floodplain, with interspersed deciduous and coniferous trees. Depending on the success of various plantings, more may be used as subsequent reaches are revegetated.

Disturbance is the force that creates and maintains wetlands and molds the floodplain. The channel will migrate. Off-channel created wetlands slowly but surely will evolve toward drier hydrologic zones as they fill. It is our goal to restore the processes and introduce the organisms that will lead to natural recovery of the streamside area.

While plants are establishing, beavers and native ungulates will be drawn to the streamside area. Especially while the reclaimed acreage is small, damage to revegetation can be severe. Various forms of control or restricted access may be necessary until plants are well established and able to cope with grazing and browsing.

3.13 RAILROAD MATERIALS REMEDIATION

This section details the design for erosion protection and sediment control measures for railroad embankment mine waste materials in or near Reach A of Subarea 1 of the SSTOU. The measures are designed to be in compliance with the criteria set forth in the ROD (MDEQ and EPA, 1995) and the Comprehensive Remedial Design Work Plan (ARCO, 1997a). The designs described in this chapter are enhancements of the preliminary designs presented in the IDR (ARCO, 1997c). A *Conceptual Design Report* (Maxim, 1998d) for railroad material remediation identified various design options for all of Subarea 1. This section of the report details the preferred alternatives for waste areas along Reach A of Subarea 1 only. The report by Maxim (1997b) gives substantial background information about railroad construction histories and regional hydrological information which will not be repeated here.

3.13.1 Objectives

In reference to railroad materials within Reach A, Subarea 1 of the SSTOU, the ROD states "...The remedy will excavate, treat and/or cover all contaminated railroad bed materials that pose a risk to human health or the environment..." and "...Monitoring and maintenance of the remediated railroad materials will be required to ensure that contaminant sources are not exposed as a result of erosion and do not cause future contaminant loading to the stream...". The Comprehensive Remedial Design Work Plan lists several remediation objectives for railroad materials. One of these objectives is applicable to Reach A, the "...Removal, treatment, or capping of contaminated railroad materials from all railroad lines that contribute runoff directly to the stream or to reclaimed areas of the floodplain...". Both the ROD and the Comprehensive Remedial Design Work Plan address railroad materials in direct contact with the stream and concentrate spills; none of these conditions occur within Reach A. Therefore, based on the ROD and the Comprehensive Remedial Design Work Plan, the primary objective of the selected design for contaminated railroad materials within Reach A is containment of the arsenic and metals contaminated sediment.

3.13.2 Design Criteria

Within and adjacent to Reach A, there are only two sources which threaten to impact the remediated floodplain of Silver Bow Creek. The first source is railroad embankments which are contaminated and which have the potential for eroding arsenic and metals contaminated sediment onto the remediated floodplain. All of the contaminated areas are on either the BA&P or the Milwaukee Road rail beds, or on cut slopes adjacent to the rail beds. Some of the contaminated areas are on the railroad embankment slopes that are not directly adjacent to the Silver Bow Creek floodplain, but still have the potential to contribute contaminated sediment into a culvert or other drainage structure that leads to the floodplain.

The second source is contaminated embankments outside of the SSTOU having the same erosional potential as areas within the operable unit. The Neversweat and Washoe Railroad, which runs along the hillside northeast of Rocker and enters the SSTOU just east of Rocker, has many contaminated embankment areas identified (ARCO, 1997c). These areas have been observed to produce eroded arsenic and metals contaminated sediment which eventually migrates to the Silver Bow Creek floodplain.

The following design criteria are common to both sources of contamination within Reach A:

- Minimize disturbance of contaminated areas
- Minimize maintenance of remediated areas
- Prevent future impacts to the remediated floodplain
- Utilize a cost effective design

The *Conceptual Design Report* (Maxim, 1998d) identified a selected design for each of these sources. For those areas potentially affecting the remediated floodplain, capping was selected as the preferred method for containment of contaminated railroad materials. For areas outside the OU, sediment detention was selected as the preferred design.

3.13.2.1 Areas Potentially Affecting the Remediated Floodplain

The main purpose of treating the areas which have the potential for affecting the remediated floodplain is to dissipate the energy of rainfall and prevent the movement of sediment. In addition to complying with the criteria stated above, this aspect of the design also meets criteria allowing free flow of groundwater to prevent excessive embankment pore pressures, and preventing vegetation from growing from within at least ten feet of active rail lines.

3.13.2.2 Areas Outside of the Operable Unit

Sediment basins were selected as an effective means to trap contaminated sediments from entering the remediated floodplain. This aspect of the design meets the common criteria listed above. More specifically, sediment basin designs are in accordance with the requirements of the *Montana Sediment and Erosion Control Manual* (MDEQ, 1996). Each basin design provides sufficient capacity and surface area to retain sediment particle sizes equal to or greater than 0.02 millimeters (mm) during the peak flow of a 10-year, 24-hour rainfall event. The outlets of each basin need to pass at least the 10-year, 24-hour peak discharge. A spillway on each basin acts as an emergency measure during events greater than a 10-year recurrence, however no specific sizing is required by the MDEQ. The basins are considered temporary and will remain in place until remediation is completed on the Neversweat and Washoe Railroad embankments, the primary source of contaminated sediment.

3.13.3 Supporting Data

Prior to the development of the final designs in this report, ARCO presented preliminary designs in the IDR (ARCO, 1997c) for Subarea 1. The IDR contained maps identifying areas of waste material and concentrate spills within Subarea 1, based on field efforts by ARCO. Maxim conducted additional field verification and sampling work in 1997 to validate and enhance the ARCO work. This effort also included revised mapping of the waste and concentrate spill areas within Subarea 1. The conceptual design report (Maxim, 1998d) for railroad material remediation identified various design options for all of Subarea 1. A summary of Maxim's field efforts titled *Field Verification Results, Railroad Materials Investigation, Streamside Tailings Operable Unit Remedial Design*, which was contained within the conceptual design report, is presented in this report as Appendix K-2. Included in the field report are the chemical and sieve analyses for waste rock and concentrate spill samples taken from railroad embankments within Subarea 1.

3.13.4 Design Components

For the railroad materials within or near Reach A of Subarea 1, there are two design components: (1) a granular/rock cover for embankments which may erode contaminated sediment onto the remediated

floodplain; and, (2) sediment basins designed to control runoff from off-site embankments which may impact the floodplain through point discharges.

3.13.4.1 Rock Cover for Floodplain Protection

Locations to be remediated are shown on Sheets M10a through M10d. The rock cover option was chosen over other options (Maxim, 1998d) because it is a low cost remedy which prevents erosion of contaminated embankment material. The design consists of overlaying the waste material of the railroad embankment with a 6-inch (minimum) layer of rock material having particle sizes ranging from 3 inches to 1/4 inch (No. 4 sieve). Cover material would be placed at the shoulder of the embankment and extend down the slope and key into the remediated floodplain or existing ground at the embankment toe. At the shoulder of the embankment, the top 6 inches of waste material will be excavated and disposed in a repository. Cover material will be placed in the excavated area, flush with the top of the embankment to allow positive drainage. The cover material will then be placed on top of the slope material. No excavation of the slope material is anticipated unless it is steeper than 2 (horizontal) to 1 (vertical), in which case it will be reduced to 2:1. Any areas on cut slopes leading down to a railroad embankment will have the toe area designed to maintain drainage ditches adjacent to the railroad. Details of the design are found on Sheet M10e.

During remedial construction activities, the limits of embankment remediation will be staked in the field by the Owner's Representative. The areas of remediation shown on the Drawings are approximate and are intended to provide the Contractor with estimated locations and quantity estimates.

Appendix K-3 shows spreadsheet printouts of the volume estimates for rock cover for each delineated area in Reach A.

3.13.4.2 Sediment Basins for Off-Site Retention

Appendix K-1 contains the design calculations for each of the eight sediment basins adjacent to Subarea 1. Sheets M10f and M10g show the designs for the three basins being constructed adjacent to Reach A. The basins also are designed to have sediment storage volume (3 feet depth at the bottom of the basin). The storage volume was not designed for a specific period of time. If the basins remain in place for several years, periodic maintenance is anticipated. Water from the catchments would infiltrate or evaporate. There is the potential that water quality in the basins will not meet human health safety standards. Therefore, fences will be installed around the basins to prevent public access.

This section describes the design for all eight basins adjacent to Subarea 1. Adjacent to Reach A, three basins will be constructed at the locations shown on Sheets M10c and M10d. The catchment basins' shapes are specific to each individual drainage. Six of the basins were designed for drainage areas bounded by I-90/15 to the north and Old Highway 10 to the south. The drainage areas for these basins ranged from 5.5 to 35.2 acres. The remaining two basins had larger drainage areas. Because of a 36-inch culvert under I-90/15, the drainage for basin S5 included areas north of the Interstate, for a total of 0.19 square miles. The drainage area for basin S1 is approximately 0.87 square miles. This drainage was targeted for a sediment basin because of the potential for sediment movement from the Neversweat line north of I-90/15. Table 3.13-1 summarizes the pertinent design information for each basin. For Reach A, basins S1, S2, and S3 will be constructed. Basins S4 West and S4 East are located where the current rock material stockpiles reside. These two basins, along with basins S-5 through S-7, will be constructed sometime after Reach A construction is complete, likely during Reach B construction activities.

Runoff was estimated by two different methods. For the smaller basins with drainage areas ranging from 5.5 to 51.5 acres, the Rational Method (ASCE et al, 1975) was used to determine peak discharge. This method is intended for small drainage areas and peak flow for a given storm event is estimated in part by the time it takes for runoff to reach a drainage collection point. In this case, the collection point for each drainage is the

sediment basin location. The Rational Method was developed for urban areas but is applicable to undeveloped areas also.

For the larger drainage areas ranging from 0.19 to 0.87 square miles, the runoff was modeled using the program HEC-1 (U.S. Army Corps of Engineers, 1990) to obtain peak flow estimates. HEC-1 rounds the peak flow value to the nearest cubic foot per second. It also takes into account infiltration, attenuation, and storage of the runoff. HEC-1 requires rainfall and basin characteristics input and this information is detailed in Appendix K-1.

TABLE 3.13-1
SUMMARY OF SEDIMENT BASINS FOR TREATMENT OF RUNOFF FROM NEVERSWEAT AND WASHOE RAILROAD WASTE MATERIAL AREAS
Reach A (Subarea 1) - SSTOU Remedial Design

Basin Identification	Railroad Waste Areas or Drainage	Drainage Area (Acres)	Drainage Area (Square Miles)	Peak Flow From 10-Year, 24-Hr Rainfall (cfs)	Required Surface Area for Particle Retention (SF)
S7	C15	8.8	---	0.7	890
S6	C14	9.7	---	0.5	1,050
S4 (2 basins)*	C7-C10	14.4	---	1.2	1,510
S3*	C5.5	5.5	---	0.5	590
S2*	C5-C6 and C1/C2-C4	51.5	---	4.1	5,150
S5	C11-C13	---	0.19	6	7,500
S1*	Whiskey Gulch	---	0.87	8	10,000

Notes: * Basin to be built during remedial action for Reach A.
cfs = cubic feet per second; SF = square feet

The drop-inlet pipes for the basins were designed to pass at least the peak 10-year discharge for each drainage area. Basins S1, S2, and S5 require two feet of head above the pipe inlet crest to pass the design flow. Basins S3, S4, S6, and S7 will pass the design flow with one foot of head. All pipes are 12 inches in diameter and are made of high density polyethylene (HDPE). The spillways for each basin were designed to pass a flow much greater than the peak associated with a 500-year return period. All spillways have bottom widths of 10 feet and 2:1 side slopes. Basins S1, S2, and S5 have two-foots depths at the control section. Basins S3, S4, S6, and S7 have control section depths of one foot. Design computations call for 6-inch nominal diameter riprap in the spillways. Type 2 stone with a nominal diameter of 7 inches will be used for spillway construction. The upstream inlet section of each basin will be lined with Type 2 stone to prevent erosion.

Appendix K-1 has spreadsheet printouts of the estimated cut and fill for each basin. In all cases, the cut exceeds the embankment fill quantity to account for compaction of the on-site material.

Appendix K-1 also contains soil properties and slope stability computations for the off-site sediment basins. The soil properties are reported as gradation and moisture-density test results from the on-site material at each basin location. Appendix K-1 contains slope stability model outputs for a typical basin embankment berm

approximately 9 feet high. The soil properties used in the stability analyses are taken from the sample for basin S1 which is basically a sand having a low fraction (approximately 5%) of fine particles passing the No. 200 sieve. Basin S6 has a particle size distribution similar to basin S1. The soil samples from the other basins had higher fractions of fine particles. Therefore the stability analyses in Appendix K-1 are conservative for basins other than S1 and S6 because a sandy material is less stable than a material with higher fractions of fine particles. Basin S2 is higher than 9 feet but has approximately 22% fine particles in the on-site soil. The analyses in all cases assumed the upstream pool is full with two feet of freeboard. Four models were run for the analyses. The input factors and factors of safety are summarized in Table 3.13-2. The model results are included in Appendix K-1.

The designs for the basin berms, based on the results of Table 3.13-2, are to have 3:1 slopes on both the upstream and downstream faces. Because of the sandy nature of the soil, some seepage may occur through the embankments. This was evident with the basin used for the Pilot Test. But it appears that the embankments will remain stable, even with the phreatic surface exiting the downstream face 2 feet above the downstream toe. Lining of the berms is not necessary. Seismic analyses were not conducted because of the remote possibility of an earthquake event during the short time the basins may experience full pools.

TABLE 3.13-2
SUMMARY OF SLOPE STABILITY ANALYSES FOR SEDIMENT BASINS TREATING RUNOFF FROM NEVERSWEAT AND WASHOE RAILROAD WASTE MATERIAL AREAS
Reach A (Subarea 1) - SSTOU Remedial Design

Model Name	Berm Face	Slope (horiz:vert)	Phreatic Surface Exit Point on Downstream Face	ϕ (degrees)	Unit Weight, γ_m (pcf)	Factor of Safety for Sliding
Stream.1	Upstream	3:1	toe of berm	30	110	2.1
Stream.2	Downstream	2:1	toe of berm	30	110	1.0
Stream.3	Downstream	2:1	toe of berm	32	110	1.1
Stream.4	Downstream	3:1	2 ft above toe of berm	32	100	1.5

Notes: pcf = pounds per cubic foot

3.14 OTHER CONSIDERATIONS

This section discusses other concerns and issues important to the design and construction of the Remedial Action in Reach A of Subarea 1. While there is generally not a design basis associated with all of the considerations listed below, the design approach to many of them is guided in some manner by the ROD, the Comprehensive Remedial Design Work Plan, or other direction given by the Agencies.

3.14.1 ARARS Compliance

In the Introduction of the ROD, MDEQ notes the following: "Section 121(d) of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 U.S.C. Section 9621(d), certain provisions of the current National Contingency Plan (NCP), 40 CFR Part 300 (1990), and guidance and policy issued by the EPA require that remedial actions taken pursuant to Superfund authority shall require or achieve compliance with substantive provisions of applicable or relevant and appropriate requirements (ARARs), standards, criteria, or limitations from state environmental and facility siting laws and from federal environmental laws at completion of the remedial action...". Only the substantive portions of the requirements

are ARARs. Administrative requirements, such as guidance, consultation, permitting, and enforcement are not ARARs. The CERCLA program has its own set of administrative procedures which assure proper implementation of CERCLA.

The ROD outlined the elements of the remedial action that would be required to be protective of human health and the environment and comply with ARARs. The final design for Reach A has been developed using the ROD as primary guidance for design decisions that have been made as the design progressed from its preliminary form to the end result presented in this document. For each component of the design, several altemative designs were considered prior to making the design decision that advanced the selected design. Alternative designs were evaluated for both implementability and cost as well as effectiveness in meeting the appropriate ARARs and ROD requirements. This process was performed in consultation with the appropriate agencies and with the ultimate goal of implementing a remedy that complies with the substantive provisions of the ARARs identified in the ROD. The Performance Standards Compliance Plan, which will be presented concurrently with the Final Design Report, describes the ARARs for the Remedial Action and indicate how ARARs are met with the selected design.

3.14.2 Upstream Cleanup

The proposed remedy will be coordinated with other clean up activities along Silver Bow Creek. Upstream remedies which are currently under construction and which will be substantially completed prior to initiating construction in the SSTOU include the removal of the Colorado Tailings and the construction of sediment basins in Missoula Gulch. These two actions are expected to contain or control the majority of contaminated upstream inputs that would affect the SSTOU.

Off-site impacts that potentially may affect Silver Bow Creek with releases of contaminated sediments are generally confined to the gulches entering the Operable Unit from the north of the creek. Potential sediment inputs from off-site contaminated railroad embankments will be controlled with the use of sediment basins constructed near the point of entry to the Operable Unit. For contaminated sediment inputs that may be generated during and following Remedial Action, strategically placed sediment basins of a sufficient size and capacity will be constructed.

3.14.3 Construction Sequencing

The sequencing of construction is described in detail in the Special Provisions, contained in Appendix A of this report. Because of the numerous activities of the project, and the need for simultaneous work efforts, the sequencing of construction is complex and will require very controlled construction management. The construction effort will have to be ambitious during the first few weeks of the project to allow subsequent, time-consuming tasks to proceed. As an example, initial work to simultaneously prepare MWRR 2, construct the diversion channel, and construct groundwater dewatering systems will have to be accomplished in a relatively short period of time in order to begin excavation of the tailings/impacted soils in the floodplain. Numerous construction crews will be needed to perform at the same time on different parts of the project.

3.14.4 Permit Requirements

Those portions of the Remedial Action conducted on-site are exempt from other state and federal permitting authorities under the provisions of CERCLA. However CERCLA does require that remedial actions comply with the identified regulations and statutes governing permit authorities. This section summarizes the permit requirements that have been considered in completing the design components for the final design. Many of these permit requirements are covered through on-going consultation or memoranda of understanding with other state and federal agencies. Other requirements are addressed through ARARs compliance. Off-site actions require normal permitting.

3.14.4.1 Air Quality

Emission of more than 25 tons per year of any pollutant as a result of site activities would normally require a permit from the MDEQ Air and Waste Management Bureau. Primary emissions from this remedial action will include release of particulates in the form of dust from excavation operations, release of lime dust during lime application, and release of smoke from burning. Because dust controls will be required and burning will be restricted, exceedance of the permit prerequisite is not expected.

3.14.4.2 High Hazard Dam

When an impoundment greater than 50 acre-feet is constructed, a hazard classification permit is generally required from the Department of Natural Resources and Conservation (DNRC) Dam Safety Program. None of the stormwater detention basins constructed for the remedial action will exceed the permit prerequisite.

3.14.4.3 Floodplain Development

Any new construction, substantial improvement, or alteration of an artificial obstruction within a floodplain or floodway normally requires a permit from the Butte-Silver Bow County Floodplain Administrator. In Reach A of Subarea 1, the floodplain will be completely reconstructed through removal of all tailings/impacted soils and replacement with clean soil material to a design elevation. One bridge crossing of Silver Bow Creek will be removed and replaced with a crossing of a similar design. The Agencies will consult with Butte-Silver Bow County regarding this issue. After the floodplain for Subarea 1 has been reconstructed, MDEQ will prepare a new floodplain map for floodplain and floodway management agencies.

3.14.4.4 Burning

No burning will be allowed for this project.

3.14.4.5 Non-Hazardous and Hazardous Solid Waste Disposal

All non-hazardous waste generated during implementation of the Remedial Action which is to be disposed of off-site will be disposed in a licensed solid waste management facility. The required permits are maintained by the disposal facilities.

Tailings/impacted soil, contaminated in-stream sediments and contaminated railroad materials will be disposed in an on-site mine waste relocation repository. The on-site repository will be designed in compliance with the substantive requirements of the Solid Waste Management Act and other ARARs.

Hazardous ore concentrate spills will be disposed in a Resource Conservation and Recovery Act (RCRA) Subtitle C repository. However, there are no concentrate spills located along the railroad lines in Reach A.

3.14.4.6 Highway Encroachment

Encroachment on highway right-of-way normally requires a permit from the Department of Transportation (DOT). The DOT has been contacted for this issue.

3.14.4.7 Stream Protection Act Permit

To comply with the Stream Protection Act, construction within any stream channel or bank generally requires a permit from the Montana Department of Fish, Wildlife, and Parks. The Remedial Action will reconstruct a substantial portion of the stream channel and replace the streambanks in Reach A. To comply with the

substantive provisions of the permit requirements, the design has been developed in consultation with Fish, Wildlife, and Parks personnel.

3.14.4.8 Montana Pollutant Discharge Elimination System (MPDES)

Point source discharges of pollutants into state surface waters generally require a MPDES permit from the MDEQ Water Protection Bureau. The elements that will be used to implement the design for construction dewatering would normally prompt the need for this permit. The Remedial Action will need to meet the substantive provisions of these requirements.

3.14.4.9 Weed Control

The Montana County Noxious Weed Management Act requires that a weed control plan be submitted to the County Weed District Supervisor. A weed control plan will be prepared and submitted to the Butte-Silver Bow County Weed District for review.

3.14.4.10 Section 404 of the Federal Clean Water Act

Discharge of dredged or fill material into a water body or wetland requires a 404 permit from the U.S. Army Corps of Engineers. Compliance with this section of the act will be achieved through consultation with the Corps of Engineers. The Agencies and Corps of Engineers have established a protocol to address this issue.

3.14.4.11 Montana Ground Water Pollution Control System

Discharge of pollutants into ground water normally requires a permit from MDEQ Water Protection Bureau. Elements of the design that may impact ground water include construction dewatering, construction of a MWRR, excavation and removal of saturated tailings, and use of sediment basins to contain contaminated runoff from mine waste impacted railroad embankments. These elements of the design were developed in consultation with MDEQ to meet the substantive requirements of the Montana Ground Water Pollution Control System requirements.

3.14.4.12 Natural Streambed and Land Preservation Act 310 Permit

Physical alteration of a stream channel or bank normally requires approval from the DNRC Conservation Districts Division and the local Conservation District. Through consultation with the DNRC and the local Conservation District, the design meets the substantive requirements of this permit.

3.14.4.13 Permit to Appropriate Water

Withdrawal of any surface water requires a permit to appropriate water from the DNRC Water Rights Bureau. It is likely that water will be drawn from Silver Bow Creek during construction for dust control on haul routes and excavation areas and for moisture control in the MWRR. MDEQ and ARCO have reached an agreement to allow the RA construction contractor to use Silver Bow Creek water for construction purposes under ARCO's existing water appropriation right. The DNRC Water Rights Bureau has verbally approved this arrangement, with the condition that the total construction use for one year is less than the appropriated volume limit of 6.19 acre-feet. Anticipated construction use is less than the appropriation.

A water right will not be required to divert Silver Bow Creek through the constructed diversion channel since this is not considered a beneficial use of water.

3.14.5 Utilities

Utilities in Reach A include two Butte water lines, the Silver Lake Pipeline, a buried fiber optic telephone line, a sewage sludge pipeline, and aerial phone and power lines. The Butte water lines cross the Operable Unit over Silver Bow Creek at two aerial crossings between the Interstate bridges. The Silver Lake pipeline is present in the western half of Reach A, running along the northern boundary of the floodplain. A buried fiber optic telephone line and sewage sludge line generally run parallel to old Highway 10. Aerial phone and power lines maintained by Montana Power and U.S. West are present on both the north and south sides of Silver Bow Creek in Reach A, cross the borrow area and the mine waste repository site planned for the Remedial Action, and run parallel to the major county roads and planned haul routes. Where haul routes cross through the Rocker Operable Unit, buried gas, water, and sewer lines are present.

Any of the utilities that may be impacted by the Remedial Action will be protected, relocated, or replaced in cooperation with the controlling utility. Consultation with the utility companies is on-going and any agreements or provisions that will be emplaced during and after construction will be finalized prior to requesting bids for the project.

3.14.6 Greenway Service District and the Greenway Trail

The Greenway Service District has been established by the Butte-Silver Bow and Anaconda-Deer Lodge local governments for the purpose of guiding future planning and land use along the Silver Bow Creek corridor and overseeing the Greenway design, development, and operations. The Greenway is a development envisioned by community leaders in the Butte and Anaconda area to transform neglected landscape into an aesthetic corridor offering recreational opportunities. A Preliminary Design Report for the Greenway was developed by Pioneer Technical Services, Inc. and EDAW, Inc. (1998). A comprehensive discussion of planning, coordination, design, and proposed features of the Greenway is contained in the report. One of the principles used to guide development of the Greenway is that it "...should be closely coordinated with the remediation project and the two projects should be mutually reinforcing." (Pioneer and EDAW, 1998). The design of the remediated floodplain along Reach A of Silver Bow Creek has been coordinated with the Greenway design and the Greenway trail alignment and design plans have been appended to this report. The final contours of the reconstructed floodplain will accommodate easy placement of the Greenway trail when funding is available to construct it. Diversion channel and stream crossings for the trail will not be constructed as part of the RA construction and will be installed by the Greenway Service District at a later date. The proposed trail and crossings have been designed to have minimal impact on channel and floodplain hydraulics. A proposed parking lot and trailhead at Whiskey Gulch will not be part of the RA activities and will be constructed later under the direction of the Greenway Service District.

3.14.7 Rocker

The construction of the Remedial Action in Reach A of the SSTOU will impact the town of Rocker and adjoining residences primarily through an increase in activity and traffic in and near the towns. The major portion of the traffic increases realized through Rocker will be workers commuting to the staging areas each day. Fredricksburg residents will be affected by construction traffic crossing the county road east of Rocker between the main borrow area and the excavation area. Except for construction traffic associated with the borrow area, commuter traffic, and commercial/Interstate access, all other construction activities will be restricted to the Operable Unit upstream of the county road crossing Silver Bow Creek above Rocker.

As discussed in the Transportation Plan (Appendix E), haul truck traffic will be routed around Rocker on the south side of Silver Bow Creek. While the noise and activity associated with remedial construction activities will be noticeable, careful control of traffic patterns will be achieved using signage and flagging. These measures, along with dust control, will minimize, to the extent possible, direct impacts to residents in the surrounding area.

3.14.8 Roads and Highways

Roads and highways will be affected by Remedial Action construction in Reach A primarily through use by workers commuting to the site, transport of construction equipment and materials, and haulage of considerable amounts of borrow and tailings/impacted soil. The major roads that will be impacted include I-90/15, State Highway 10, and county roads and crossings.

Interstate 90/15 will be the primary access for workers and delivery of equipment and materials to the site. Either the Rocker interchange or the Montana Street exit will be used for access on and off the Interstate.

The two Interstate bridges and the accompanying bridge piers and embankment fills are also immediately adjacent to the upper end of Reach A where tailings removal and streambank reconstruction will occur. Remedial Action construction will not impact either the bridge supports or the embankment fills. Care will be taken during construction in this area to protect the integrity of these structural elements.

Old Highway 10 through Rocker (frontage road) and the abandoned portion of Highway 10 east of Rocker will be affected by both commuter and transport traffic and construction. A considerable portion of materials delivered to the site and much of the workers commuting to the site will pass through Rocker on the frontage road. The abandoned portion of Highway 10 east of Rocker may be affected by construction of MWRR 2.

The county road between Rocker and Butte will also provide primary access to the site and will be used to circumvent Reach A. The county road will not be used for haulage of borrow materials or excavated tailings/impacted soil. Traffic on the county road may be disrupted by haul truck crossings and construction of a new stream crossing at the county road crossing west of the Interstate bridges.

3.14.9 Railroads

Two active rail lines parallel Reach A, the BA&P operated by Rarus and the UP-MW. Both rail lines cross the county road east of Rocker at signed intersections. The BA&P line will also be crossed by haul traffic moving borrow materials from Borrow Area 10. Activities in Reach A that require remediation of railroad materials will only affect the BA&P. All aspects of the design that impact the rail operations will be coordinated with the railroad companies. The UP-MW line is not expected to be impacted by work in Reach A other than increased traffic at the county road crossing east of Rocker.

3.14.10 Land Ownership

Table 3.14-1 lists the majority of the private landowners on whose lands where remedial construction activities will take place. The majority of the land is owned by ARCO, Blue Bird Mining Company, and BGME, L.L.C. Arrangements with all private landowners other than ARCO will be needed prior to initiation of Remedial Action.

For all remedial construction activities, property involved in the project will not be unnecessarily disturbed without prior access from the landowner. Fences will be maintained in a condition equal to the existing condition and gate closures will be respected where gates are necessary to control ingress and egress. All trash will be disposed in containers and littering is prohibited. No overnight camping will be allowed.

3.14.11 Historic Resource Preservation

A cultural resource inventory was conducted and prepared by GCM Services, Inc. (1992) for the SSTOU under contract to ARCO. The inventory compiled data on identified sites and evaluated those sites as to significance within the guidelines of the National Register of Historic Places (NRHP). Impacts to the sites will be associated with tailings removal, MWRR construction, borrow area development, construction of haul routes, sediment basin construction, and mitigation of railroad embankments. Treatment of impacts to sites

eligible to the NRHP follows the designs of the Anaconda-Butte Heritage Corridor Regional Historic Preservation Plan. All affected sites located within Reach A of Subarea 1 have been treated by off-site mitigation in accordance with the Second Programmatic Agreement Regarding Implementation of the CERCLA Related Elements of the Upper Clark Fork Basin Regional Historic Preservation Plan (2ndPA) (EPA, 1994).

TABLE 3.14-1
LANDOWNER LIST - REACH A REMEDIAL CONSTRUCTION
Reach A (Subarea 1) - SSTOU Remedial Design

LANDOWNER	PARCEL NO.
ARCO and Blue Bird Mining Company	236
ARCO	231, 232, 233, 238
BGME, L.L.C.	228, 210B
Blue Bird Mining Company, Mary Gavin Ryan, and Washing Trust Bank	239
Blue Bird Company	201
Blue Bird Mining Company	201
Bluebird Mining Company	217
Bossard and Caboose Mining Enterprise, Inc.	230
Frank M. Antonioli and Floyd C. Bossard	208
Geraldine Corn and Blue Bird Mining	225
Jack L. and JoAnn McLeod and ARCO	225
Ray B. And Connie Palmer	225
Rocker Holdings, L.L.C.	201
West Butte Land and Anaconda Company	208
West Butte Metals, Inc	240
Mark P. Sullivan, Trustee	214

Notes: Property Ownership information from land acquisition status maps prepared for ARCO by Titan Environmental, dated 6-20-97, Sheets 1 through 4

If unknown or undocumented historic properties are discovered during response actions, construction will be halted in the immediate area of the discovery and an archeologist will be notified to verify its significance. All parties to the 2nd PA and interested tribal authorities will be notified, and the Community Historic Preservation Officer will visit the property prior to any further action. Decision concerning necessary treatment of the discovered historic property will be made by the EPA in consultation with other parties to the 2nd PA.

In Reach A of Subarea 1 the following historic sites were recorded in the cultural resource inventory:

- Carver Placer — Located upstream of the county bridge east of Rocker, this site has placer diggings on the south side of Silver Bow Creek and the remnants of several structures, including a stone lined cellar, and waste piles.

• Ulrich & Sonora Placer	Located on the south side of Silver Bow Creek above the Carver Placer. This site is composed of placer mounds, ditch, a diversion structure, prospect pits and a dugout.
• Josephine & Arlington Lodes	On the north bank of Silver Bow Creek downstream of Whiskey Gulch. This site is composed of placer mounds, a ditch, a buried structure, a dugout, and a shaft with headframe.
• BA&P Historic District	This district is composed of the right of way of the railroad as it runs from Butte to Anaconda. The Rocker yards are included in the district along with the historic bridges.
• Milwaukee Road	The Milwaukee Road (Chicago, Milwaukee, and St. Paul) railway adjoins the BA&P through all of Reach A of Subarea 1. Only the railroad bed and bridges remain as the track and railroad ties were removed. Trolley line poles remain along much of the line, although only pole bases are left at many places.
• U.S. Highway 10	This historic road stretches from near Excelsior Street in Butte to a point near Ramsay where the road was replaced by Interstate 90. The highway portion through Reach A is composed of deteriorating concrete pavement and has been closed by earth berms at each end between Butte and Rocker.

In 1994, the EPA, MDEQ, ARCO, and the city and county government agencies reached an agreement regarding historic preservation for implementation of CERCLA related activities. This agreement (EPA, 1994) identified the historic properties where potential Superfund impacts may be expected and the mitigation process that would occur at these sites. Additional consultation with the Salish and Kootenai Confederated Tribe will continue, to ensure compliance with respect to Indian cultural and historic resources.

In Reach A, the two sites eligible for NRHP designation (the BA&P Historic District and the Milwaukee Road) are listed as included in the off-site mitigation package when impacts resulting from Superfund actions are unavoidable (EPA, 1994). The Remedial Design for both the BA&P and Milwaukee Road in Reach A avoids impacts to these resources. Portions of both railroad embankments that contain mine waste materials in Reach A will be covered with rock. The rock will not impact the form or function of the embankment but it will alter, to some extent, the historic visual integrity of the sites because the rock will blend with the lines of the embankment but will not completely blend with the color or texture of the surrounding materials.

Some limited haulage may occur on the highway, primarily to access the sites where stormwater detention basins will be constructed. Where the highway will be crossed by extensive haul truck traffic, an earthen cover will be placed over the highway and removed at the completion of construction activities. While historic Highway 10 was initially identified as eligible for NRHP listing in the cultural resource inventory, it was not carried forward as an historic property under the programmatic agreement (EPA, 1994).

3.14.12 Equipment Decontamination

The primary avenues of contaminant exposure to personnel and equipment will occur during tailings excavation and disposal and during treatment of contaminated railroad embankments. Personal decontamination will be addressed in separate, site specific, Health and Safety Plans that will be required of the construction and oversight contractors. This section deals solely with equipment decontamination.

Equipment decontamination will consist of removing all visible tailings/impacted soil material from the outside of the vehicle, including the wheels, tracks, undercarriages, fenders, blades, buckets, and the exterior body.

Either dry or wet methods of decontamination will be acceptable. An equipment decontamination area shall be designated near the staging area at the boundary of the tailings impacted floodplain where all decontamination procedures will be implemented.

To minimize the exposure of equipment to contaminants, all staging areas will be located in clean areas unimpacted by floodplain tailings or railroad waste materials. Vehicles used to travel in contaminated areas will be staged such that these vehicles do not leave a controlled area before decontamination. Equipment used to excavate and dispose of tailings in the Mine Waste Relocation Repositories will not be required to be decontaminated unless the equipment leaves the site to travel outside the operable unit. Any contaminated materials deposited outside the operable unit must be immediately cleaned up by the construction contractor

3.14.13 Debris Disposal

Debris in Reach A consists of a mixture of household trash, treated and untreated timbers, asphalt shingles, groundwater piezometers (both polyvinyl chloride and steel), mixed commercial and demolition debris (concrete, lumber, scrap metal, etc.), appliances, and tires. Much of the debris present in the floodplain consists of timbers and lumber with some debris associated with the three placer sites present in Reach A. Clearing and grubbing operations will also generate debris in the form of stripped sod from the floodplain and root balls. No hazardous waste is expected to be encountered during construction activities; however, contingency procedures are described in the special provisions of the bid package (Appendix A) if hazardous wastes are encountered during construction.

Debris recovered during clearing, grubbing and stripping activities will be salvaged or disposed of at a licensed solid waste disposal facility. The total amount of debris present in Reach A and in the borrow areas, sediment basins, and MWRR is estimated at 500 cubic yards for the purposes of bidding the project. The Butte-Silver Bow Landfill will accept all the debris recovered during construction for a tipping fee based on the type of debris and the cubic yardage disposed. The debris will be separated into the following types prior to disposal at the landfill:

- Treated and untreated timbers;
- Mixed commercial and demolition debris;
- Appliances;
- Concrete;
- Tires; and
- Stumps and root balls.

Large scrap metal items will be reduced to an acceptable size as required by the solid waste disposal facility and disposed as mixed commercial debris. Soil will be required to be dislodged from timbers and root balls to minimize the amount of soil or tailings/impacted soil that is disposed in the landfill. Soil shall also be screened from loads of household trash and demolition debris for the same purpose.

Clearing and grubbing activities will consist of removing woody vegetation and root balls from the excavated tailings removal area, borrow areas, MWRR 2, and the stormwater detention basins associated with the railroad remediation. Shrubs and saplings will be removed, chipped, and stockpiled for later spreading in the reclaimed floodplain. Sod stripped from the tailings excavation area will be disposed in the MWRR according to the provisions for MWRR material placement.

3.14.14 Stormwater Management and Erosion Control

A stormwater erosion control plan has been developed for the SSTOU Site (See Appendix L). Anticipated remediation construction activities associated with Reach A may disturb approximately 30 acres of Corps of Engineer (COE) wetland areas and approximately 80 acres of non-wetland areas (Sheet M3). This Plan

describes best management practices (BMPs) for sediment and erosion control which may be implemented during remediation construction activities to meet the objectives stated below:

- Preserve as much natural vegetation as possible;
- Minimize soil exposure time;
- Prevent runoff from flowing across disturbed areas;
- Stabilize disturbed soils as soon as possible;
- Minimize runoff rate across the site;
- Provide drainage; and
- Remove sediment from stormwater runoff before it leaves the site.

Best Management Practices will be constructed and implemented in accordance with the standards of practice described in the Montana Sediment and Erosion Control Manual (MDEQ, 1996). The following types of BMPs may be used separately or in combination to achieve the objectives stated above:

- Permanent cover;
- Structural erosion control;
- Sediment retention; and
- Good housekeeping practices.

BMPs may include the following:

- Preserve natural vegetation;
- Buffer zones between construction areas and surface water;
- Stabilized construction entrances;
- Dust control for haul roads and construction areas;
- Surface roughening;
- Check dams;
- Vegetative, bioengineering and/or structural stream bank stabilization;
- Filter fence; and
- Straw bale barriers.

During construction, qualified personnel will inspect disturbed areas, structural control measures and locations where vehicles access construction areas on a regular basis. An inspection report will be prepared and signed by the inspector following each inspection.

A copy of the Stormwater Erosion Control Plan will be maintained at the Project site for the life of the Project. Following completion of SSTOU Subarea 1, Reach A remediation construction activities, a copy of all records and information resulting from sediment and erosion control monitoring activities will be submitted to MDEQ.

4.0 ANCILLARY PLANS

The Comprehensive Remedial Design Work Plan identified five plans to be developed as part of the RD. The five plans are:

- The *Performance Standards Compliance Plan* identifying how the design meets ARARs and performance standards presented in the ROD;
- The *Operation and Maintenance Plan* setting forth procedures to be followed to verify maintenance of the RA;
- The *Construction Quality Assurance Plan* (CQAP) describing actions that will insure that the remedy is being constructed according to the design plans and specifications;
- The *Long-Term Monitoring Plan* identifying the parameters to be monitored to confirm that the Remedial Action meets the long-term objectives of the remedy; and
- The *Institutional Controls/Management and Maintenance Plan* identifying the types of institutionally-controlled management and maintenance that will be used in conjunction with each of the design elements to meet the design objectives.

In addition to the above five plans, the Agencies will develop an *Interim Monitoring Plan* to provide water quality and stream sediment monitoring during the construction phase of the project beyond that required by the CQAP. This plan will provide information prior to the implementation of the Long-Term Monitoring Plan during and immediately after the construction phases.

4.1 PERFORMANCE STANDARDS COMPLIANCE PLAN

The Performance Standards Compliance Plan summarizes the performance standards that will be met for each media addressed under the ROD. All ARARs as well as other standards and requirements identified in the ROD shall be incorporated into the design and documented in the Performance Standards Compliance Design Report, submitted concurrently with the FDR.

4.2 OPERATION AND MAINTENANCE PLAN

In regard to this plan, operation and maintenance means the procedures for maintaining the effectiveness of each portion of the RA upon completion of construction of each such portion. The Operation and Maintenance Plan addresses each portion of the RA. For each portion of the RA, the Operation and Maintenance Plan includes, or make reference to other plans for the following:

- A schedule of operation and maintenance (O&M) tasks needed to maintain the effectiveness of the RA;
- Procedures for all monitoring and testing for O&M;
- Contingency measures including a plan to address any failure to maintain the effectiveness of the RA;
- A description of equipment necessary for O&M; and
- Procedures for preparation of records and reporting.

This plan was approved by the Agencies in December 1998.

4.3 CONSTRUCTION QUALITY ASSURANCE PLAN

RA construction monitoring is required while construction activities are being performed. The CQAP will be implemented by the Agencies as a means of insuring the design is being constructed according to the plans and specifications and if the design elements are adequate to meet the objectives of the remedy. Quality assurance measures identified in this plan will be taken in addition to those quality control measures required of the Contractor in the technical specifications and special provisions.

The primary quality assurance elements of this plan are sampling soil material in the post-excavation floodplain for metals analysis to ensure that the order-of-magnitude criteria are met, sampling amended mine waste in the repository to ensure that lime requirements are adequate, and sampling borrow materials during excavation of borrow to ensure that borrow materials meet the backfill requirements identified in Section 3.10. This plan was approved by the Agencies in November 1998.

4.4 LONG-TERM MONITORING PLAN

After any portion or segment of construction is complete, long-term monitoring will commence. The primary purpose of long-term monitoring is to determine if the constructed remedy is meeting the remedial action objectives which are expected to be reviewed every five years by the Agencies. Long-term monitoring is expected to include monitoring the following elements or media:

- Surface Water;
- Groundwater;
- In-Stream Sediments;
- Biological (Aquatic and Terrestrial);
- Vegetation;
- In-Situ Soil Amended Areas;
- Geomorphic Stability of the Stream Channel; and
- Media Interactions.

4.5 INSTITUTIONAL CONTROLS/MANAGEMENT AND MAINTENANCE

This plan will provide a general definition and a brief discussion of the institutional controls (ICs) to be used in conjunction with other remedial measures for the remediated stream channel and floodplain and the MWRRs within and adjacent to the SST OU. This plan will also be submitted at the same time as the Final Design Report for Subarea 1. An in-depth description of types of ICs, the management and maintenance that will be used in conjunction with each of the design elements to meet the design objectives, and the identification of the entities that will implement and manage the ICs will be provided in the Institutional Controls/Management and Maintenance Plan (ICMMP). The ICMMP is expected to be prepared when RA construction for all of Subarea 1 is completed.

4.6 INTERIM MONITORING PLAN

The Interim Monitoring Plan will be developed to provide monitoring during the construction phase of the project beyond that required by construction activities. It will serve as a bridge to the Long-Term Monitoring Plan by providing information on water quality and stream sediments that can be used to ascertain the status of the stream and ecosystem during and immediately after the construction phases. At this time, the Interim Monitoring Plan will include monitoring of surface water, ground water, and in-stream sediments. For each medium, the plan will include sampling locations, frequency, and parameters to be monitored. The plan will also address sampling quality assurance/quality control, data validation procedures, and reporting.

5.0 CONSTRUCTION SCHEDULE

The proposed schedule for Reach A Remedial Action construction is shown on Figure 5-1. The schedule is broken down into the proposed bid items for construction. It does not include items which are outside of the construction bid. There other items include revegetation, rock purchase, and lime purchase. Each bid item is further broken down into work components. The schedule extends for 25 weeks, which would represent a reasonable length of time for construction during a typical construction season in Montana. The schedule is preliminary and individual work components may shift depending on the construction contractor's preference. The schedule appears to be ambitious and the contractor may be pressed to accomplish all of the work in the time allotted. The contractor will have to plan for heavy activity in the early stages of the project in order to accomplish subsequent work items. Early inclement weather may delay construction progress.

Item No.	Work Item	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10	Week 11	Week 12	Week 13	Week 14	Week 15	Week 16	Week 17	Week 18	Week 19	Week 20	Week 21	Week 22	Week 23	Week 24	Week 25
1	MOBILIZATION AND DEMOBILIZATION																									
	MOBILIZATION																									
	CONSTRUCT STAGING AREAS, DECONTAMINATION AREAS																									
	CONSTRUCT OFFICE AND SUPPORT FACILITIES																									
	DECONTAMINATION AND DEMOBILIZATION																									
2	CLEARING AND GRUBBING																									
	MWRR 2																									
	DIVERSION CHANNEL																									
	DIVERSION STRUCTURE																									
	HAUL ROADS																									
	FLOODPLAIN																									
	BORROW AREA 10																									
3	DEBRIS DISPOSAL																									
	MWRR 2																									
	DIVERSION CHANNEL																									
	DIVERSION STRUCTURE																									
	HAUL ROADS																									
	FLOODPLAIN																									
	BORROW AREA 10																									
4	HAUL ROADS																									
	HAUL ROAD CROSSINGS IN DIVERSION CHANNEL																									
	HAUL ROAD FROM FLOODPLAIN TO MWRR 2																									
	HAUL ROAD FROM REACH A TO BORROW AREA 10																									
	STREAM CROSSING EAST OF ROCKER																									
	STREAM CROSSING WEST OF ROCKER																									
	APPROACHES TO RAILROAD CROSSINGS																									
	REMOVE DIVERSION CHANNEL CROSSINGS																									
	RECLAIM HAUL ROADS IN VICINITY OF REACH A																									

Remedial Action Schedule
Streamside Tailings Operable Unit
Subarea 1, Reach A
Silver Bow Creek, Montana
FIGURE 5-1

Item No.	Work Item	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10	Week 11	Week 12	Week 13	Week 14	Week 15	Week 16	Week 17	Week 18	Week 19	Week 20	Week 21	Week 22	Week 23	Week 24	Week 25
5	TRAFFIC CONTROL																									
	INSTALL SIGNAGE																									
	PROVIDE TRAFFIC CONTROL AT PUBLIC ROAD AND RAILROAD CROSSINGS																									
6	GROUNDWATER DEWATERING																									
	CONSTRUCT SEDIMENT PONDS																									
	INSTALL SUMPS AND PUMPING SYSTEMS																									
	EXCAVATE TRENCHES																									
	OPERATE AND MAINTAIN DEWATERING SYSTEMS																									
	RECLAIM SEDIMENT PONDS, SUMPS, AND TRENCHES																									
7	TAILINGS/IMPACTED SOILS EXCAVATION AND HAULING TO MWRR 2																									
	DIVERSION CHANNEL																									
	FLOODPLAIN BETWEEN INTERSTATE BRIDGES																									
	DIVERSION STRUCTURE																									
	FLOODPLAIN DOWNSTREAM OF INTERSTATE																									
	HAUL ROADS																									
8	INSTREAM SEDIMENT EXCAVATION AND HAULING TO MWRR 2																									
	STREAM CHANNEL UPSTREAM OF STA. 12+00																									
	STREAM CHANNEL DOWNSTREAM OF STA. 12+00																									
9	DIVERSION SYSTEM																									
	EXCAVATE CHANNEL																									
	INCIDENTAL DEWATERING																									
	CONSTRUCT ADJACENT BERM																									
	PLACE RIPRAP IN CHANNEL																									
	CONSTRUCT OUTLET EROSION PROTECTION																									
	CONTRUCT DIVERSION STRUCTURE BERM																									
	CONSTRUCT HEADGATES																									
	DIVERT SILVER BOW CREEK INTO DIVERSION CHANNEL																									

Remedial Action Schedule
Streamside Tailings Operable Unit
Subarea 1, Reach A
Silver Bow Creek, Montana
FIGURE 5-1 cont.

Item No.	Work Item	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10	Week 11	Week 12	Week 13	Week 14	Week 15	Week 16	Week 17	Week 18	Week 19	Week 20	Week 21	Week 22	Week 23	Week 24	Week 25
10	MWRR 2 PREPARATION																									
	TOPSOIL STOCKPILING																									
	ACCESS ROAD CONSTRUCTION																									
	CONSTRUCT TEMPORARY RUNON DITCHES, RUNOFF DITCHES, AND SEDIMENT BASINS																									
11	MWRR 2 SOIL LIME TREATMENT, PLACEMENT, AND COMPACTION																									
	AMENDMENT MIXING TEST																									
	SPREAD TAILINGS/IMPACTED SOIL, INSTREAM SEDIMENTS, AND RAILROAD WASTE MATERIAL																									
	MIX LIME MATERIAL, COMPACT TREATED SOILS																									
12	MWRR 2 SOIL CAP																									
	REPLACE TOPSOIL																									
	EXCAVATE, HAUL, AND PLACE BORROW MATERIAL																									
	CONSTRUCT PERMANENT RUN-ON DITCHES																									
13	RECONSTRUCTED CHANNEL CORRIDOR CONSTRUCTION																									
14	DEFORMABLE CHANNEL RECONSTRUCTION: POOL SECTIONS																									
15	DEFORMABLE CHANNEL RECONSTRUCTION: RIFFLE SECTIONS																									
16	ORGANIC SOIL AMENDMENT																									
17	COUNTY ROAD CULVERT CROSSING																									
18	NON-DEFORMABLE STREAM CHANNEL RECONSTRUCTION																									
	COFFERDAM DEWATERING																									
	STREAMBED MATERIAL PLACEMENT																									
	STREAMBANK CONSTRUCTION AND REVEGETATION																									

Remedial Action Schedule
Streamside Tailings Operable Unit
Subarea 1, Reach A
Silver Bow Creek, Montana
FIGURE 5-1 cont.

Item No.	Work Item	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10	Week 11	Week 12	Week 13	Week 14	Week 15	Week 16	Week 17	Week 18	Week 19	Week 20	Week 21	Week 22	Week 23	Week 24	Week 25
19	RAILROAD MATERIALS REMEDIATION ROCK COVER																									
	WASTE MATERIAL EXCAVATION AND HAULING TO MWRR 2																									
	PLACEMENT OF ROCK COVER																									
20	RAILROAD MATERIALS REMEDIATION SEDIMENT BASINS																									
	SEDIMENT BASIN S1																									
	SEDIMENT BASIN S2																									
	SEDIMENT BASIN S3																									
21	EXCAVATION AND PLACEMENT OF NON-IMPACTED FLOODPLAIN MATERIALS																									
22	BORROW AREA 10 PREPARATION AND FINAL GRADING																									
23	BORROW AREA 10 EXCAVATION, HAULING, AND PLACING FLOODPLAIN BACKFILL																									
24	FARM FENCE																									
	FLOODPLAIN/BORROW AREA 1																									
	MWRR 2																									
25	COMBINATION FENCE																									
26	POLE FENCE																									
27	SITE SECURITY																									
28	PROVIDE WATER																									
29	GREENWAY TRAIL																									
30	DRAINAGE SWALE																									

Remedial Action Schedule
Streamside Tailings Operable Unit
Subarea 1, Reach A
Silver Bow Creek, Montana
FIGURE 5-1 cont.

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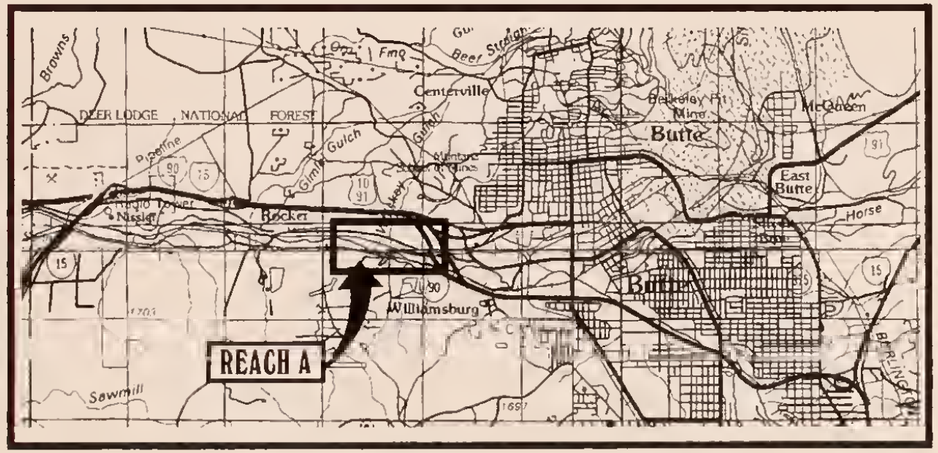
PLAN SHEETS

FINAL DRAWINGS FOR REMEDIAL ACTION

SILVER BOW CREEK / BUTTE AREA NPL SITE
STREAMSIDE TAILINGS OPERABLE UNIT, SUBAREA 1, REACH A



PREPARED FOR:

THE MONTANA DEPARTMENT OF ENVIRONMENTAL QUALITY
MINE WASTE CLEANUP BUREAU

AND

THE U.S. ENVIRONMENTAL PROTECTION AGENCY

PREPARED BY:

MAXIM Technologies Inc
Helena, Montana 406.443.5210

INTER-FLUVE, INC.
Bozeman, Montana (406) 586-6926

PIONEER TECHNICAL SERVICES, INC.
P.O. BOX 3446
BUTTE, MT 59702
(406) 782-6177

Sheet Number	Title
P1	Cover Sheet
	Greenway Trail Alignment
P2	Stations 12+00 to 26+50
P3	Stations 27+00 to 40+50
P4	Stations 41+00 to 53+00
P5	Stations 53+50 to 65+00
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P10	Typical Greenway Trail Details
P11	Whiskey Gulch Station Plan
P12	Horizontal and Vertical Alignment Data

JOEL L. GERHART 9742 PE — MONTANA — REGISTERED PROFESSIONAL ENGINEER

PIONEER TECHNICAL SERVICES, INC.

Sheet Number	Title
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M3	General Site Plan
M4 a-d	Existing Conditions
M5 a-d	Staking Plan
M5 e	Survey Control and Staking Elevations
M5 f	Haul Road Staking Plan Floodplain Crossings
M6 a-d	Groundwater Dewatering Plan
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WILLIAM H. BUCHER 4548 ES — MONTANA — REGISTERED PROFESSIONAL ENGINEER

MAXIM TECHNOLOGIES, INC.

Sheet Number	Title
I1	Site Plan of Reach A
	Plan and Profile
I2	Reconstructed Channel 0+00 - 12+00 Diversion Channel D0+00 - D2+35.2
I3	Reconstructed Channel 14+00 - 28+00 Diversion Channel D+00 - D14+27.7
I4	Reconstructed Channel 26+30 - 43+80 Diversion Channel D14+27.7 - D31+50
I5	Reconstructed Channel 42+00 - 59+10 Diversion Channel D29+61.1- D43+50
I6	Reconstructed Channel 57+00 - 69+50 Diversion Channel D44+00 - D58+62.09
	Reconstructed Channel Cross Sections
I7	Stations 0+00 to 11+50
I8	Stations 12+00 to 28+00
I9	Stations 29+00 to 43+15
I10	Stations 43+80 to 57+00
I11	Stations 58+00 to 69+00
I12	Typical Bank Treatment Details
I13	Coir Fabric Installation
I14	Fabric Wrapped Lift Assembly
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	Diversion Channel Cross Sections
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I17	Stations D10+00 to D19+00
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I19	Stations D25+50 to D30+00
I20	Stations D30+50 to D40+00
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I22	Stations D55+50 to D56+00
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I23	Diversion Structure
I24	Diversion Channel
I25	Diversion Channel Outfall and Haul Road Crossing
I26	County Road Crossing
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MICHAEL ROTAR 13285 PE — MONTANA — REGISTERED PROFESSIONAL ENGINEER

INTER-FLUVE, INC.

June 18, 1999

COVER Sheet 1

CONTROL POINTS

Survey Control Station	Northing	Easting	Elevation
CCH-6300-A	743077	1221425	8473.40
CCH-6300-C	742930	1221410	8429.78
CCH-6310-A	743081	1221289	8420.41
CCH-6310-B	743008	1221339	8429.78
CCH-6310-C	742986	1221248	8427.82
CCH-6320-A	743136	1220979	8417.89
CCH-6320-B	743108	1220987	8429.39
CCH-6320-C	743012	1220946	8424.25
CCH-6330-A	743179	1220822	8418.77
CCH-6330-C	743109	1220783	8416.57
CCH-6340-B	743178	1220722	8419.85
CCH-6340-C	743184	1220629	8421.82
CCH-6350-A	743067	1220429	8410.84
CCH-6350-B	743076	1220444	8420.69
CCH-6350-C	743022	1220480	8417.81
CCH-6360-A	743328	1220151	8410.31
CCH-6360-B	743372	1220137	8412.91
CCH-6360-C	743252	1220126	8417.36
CCH-6370-A	743432	1219988	8412.44
CCH-6370-B	743686	1220042	8422.41
CCH-6370-C	743317	1219901	8418.60
CCH-6380-A	743565	1219732	8412.82
CCH-6380-B	743504	1219813	8429.41
CCH-6380-C	743368	1219639	8418.89
CCH-6390-A	743612	1219605	8402.83
CCH-6390-C	743451	1219497	8402.25
CCH-6100-A	743572	1219280	8400.11
CCH-6120-B	743901	1219557	8423.28
CCH-6180-C	743500	1219271	8418.82
CCH-6110-A	743752	1219094	8408.91
CCH-6110-B	743652	1219218	8423.11
CCH-6110-C	743698	1219058	8414.85
CCH-6120-A	743888	1218951	8402.42
CCH-6120-B	744104	1219012	8422.84
CCH-6120-C	743998	1218955	8411.85
CCH-6130-A	744011	1218889	8407.37
CCH-6180-C	743973	1218536	8408.43
CCH-6140-A	744023	1218578	8404.80
CCH-6140-B	744241	1218610	8414.39
CCH-6140-C	743777	1218591	8408.80
CCH-6150-A	744037	1218471	8404.31
CCH-6180-C	743909	1218443	8405.36
CCH-6160-A	743987	1218282	8402.83
CCH-6160-B	744114	1218272	8409.40
CCH-6160-C	743985	1218280	8410.87
CCH-6170-A	743994	1218148	8406.06
CCH-6170-C	743931	1218155	8412.21
CCH-6180-A	744006	1217970	8402.57
CCH-6180-C	743922	1217954	8409.44
CCH-6190-A	744264	1217766	8407.68
CCH-6190-B	744250	1217853	8408.05
CCH-6190-C	743948	1217718	8411.64
CCH-6200-A	744128	1217539	8398.88
CCH-6200-B	744292	1217553	8402.60
CCH-6200-C	744031	1217490	8407.29
CCH-6200-D	744092	1217311	8402.55
CCH-6210-A	744293	1217366	8398.93
CCH-6210-C	744305	1217412	8401.27
CCH-6220-A	744200	1217181	8397.87
CCH-6230-B	744114	1217139	8410.58
CCH-6220-C	744436	1217224	8404.22
CCH-6230-A	744346	1216949	8398.52
CCH-6230-B	744200	1216898	8407.20
CCH-6230-C	744485	1217017	8404.07
CCH-6240-A	744444	1216782	8398.89
CCH-6240-B	744348	1216725	8400.85
CCH-6240-C	744650	1216786	8400.43
CCH-6250-A	744439	1216549	8398.85
CCH-6250-C	744643	1216600	8396.44
CCH-6260-A	744566	1216391	8394.89
CCH-6260-C	744376	1216606	8402.77
CCH-6270-A	744651	1216558	8407.70
CCH-6270-C	744577	1216186	8393.06
CCH-6270-B	744610	1216139	8396.17
CCH-6270-C	744853	1216218	8411.06
CCH-6280-A	744787	1215978	8394.24
CCH-6280-B	744978	1215918	8408.94
CCH-6280-C	744594	1215894	8396.79
CCH-6290-A	744687	1215787	8394.91
CCH-6290-C	744736	1215792	8391.25
CCH-6300-A	744821	1215084	8392.89
CCH-6300-B	744737	1215459	8396.86
CCH-6300-C	745032	1215717	8407.89
CCH-6300-D	744859	1215642	8391.89
CCH-6310-A	744814	1215414	8391.11
CCH-6310-B	744780	1215419	8394.91
CCH-6310-C	745018	1215481	8408.11
CCH-6320-A	744848	1215242	8390.52
CCH-6320-B	744786	1215252	8394.40
CCH-6320-C	745010	1215118	8402.31
CCH-6330-A	744722	1213102	8392.47
CCH-6330-B	744634	1214134	8396.66
CCH-6330-C	744897	1215048	8400.44
CCH-6340-A	744787	1214910	8390.19
CCH-6340-C	744618	1214971.6	8389.79
CCH-6350-A	744857	1214952	8388.21
CCH-6350-B	744697	1214955	8394.09
CCH-6350-C	745048	1214901	8400.84
CCH-6360-D	744718	1214843	8388.21
CCH-6360-A	744733	1214433	8392.34
CCH-6360-B	748050	1214454	8400.06
CCH-6360-C	744683	1214427	8396.87
CCH-6370-A	744703	1214163	8395.16
CCH-6370-C	744625	1214155	8392.22
CCH-6380-A	744674	1213957	8387.89
CCH-6380-B	748052	1214027	8396.89
CCH-6000-C	744680	1213888	8392.82
CCH-6300-A	744848	1213711	8395.45
CCH-6380-B	748047	1213748	8396.34
CCH-6380-C	744810	1213583	8391.91
CCH-6400-A	744851	1213433	8387.84
CCH-6400-B	745147	1213492	8396.83
CCH-6400-C	744636	1213471	8396.89
CCH-6410-A	744691	1213236	8387.91
CCH-6410-C	744748	1213225	8398.38
CCH-6420-A	744843	1213083	8387.23
CCH-6420-B	748176	1213000	8394.58
CCH-6420-C	744742	1213024	8396.38
CCH-6430-A	744803	1212723	8396.67
CCH-6420-C	744813	1212885	8394.82
CCH-6440-A	744881	1213480	8393.82
CCH-6440-B	745061	1212614	8396.69
CCH-6440-C	744804	1213411	8391.84
CCH-6450-A	745042	1212121	8393.27
CCH-6400-C	744898	1212173	8394.58
CCH-6460-A	745022	1211974	8394.84
CCH-6460-B	744927	1211894	8393.80
CCH-6460-C	745271	1212126	8396.47
CCH-6470-A	745073	1211914	8393.82
CCH-6470-C	748134	1211933	8392.22
CCH-6480-A	747986	1211736	8398.58
CCH-6480-C	748188	1211756	8396.47
CCH-6490-A	745283	1211606	8396.06
CCH-6490-C	748172	1211629	8387.17
CCH-6500-A	743978	1211405	8391.36
CCH-6500-C	745200	1211388	8394.89
CCH-6510-A	743348	1211279	8386.11
CCH-6510-B	743391	1211328	8394.80
CCH-6510-C	745264	1211218	8389.80

Survey Control Station	Northing	Easting	Elevation
CCH-6570-A	746414	1211154	8383.76
CCH-6580-C	746459	1211172	8384.41
CCH-5630-A	746463	1210896	8382.46
CCH-5630-C	745515	1211021	8384.88
CCH-6540-A	745306	1210924	8382.48
CCH-6540-B	744950	1210819	8383.28
CCH-6540-C	745386	1210991	8385.01
CCH-6550-A	745884	1210824	8379.87
CCH-6560-C	745930	1210852	8378.77
CCH-6580-A	745819	1210826	8373.72
CCH-6580-C	745884	1210811	8375.52
CCH-6570-A	746550	1210404	8375.76
CCH-6570-C	745729	1210427	8377.86
CCH-6580-A	745789	1210298	8373.34
CCH-6580-C	745832	1210271	8383.18
CCH-6580-A	745884	1210154	8375.78
CCH-6600-C	745785	1210221	8373.38
CCH-6600-A	745809	1209980	8376.70
CCH-6600-C	746003	1210113	8382.28
CCH-6610-A	745867	1209766	8367.35
CCH-6610-B	745879	1209786	8375.41
CCH-6610-C	746192	1209813	8377.21
CCH-6620-A	745854	1209497	8373.34
CCH-6600-C	746083	1209824	8369.08
CCH-6620-A	746068	1209271	8366.57
CCH-6630-B	745928	1209297	8375.96
CCH-6600-C	745856	1209300	8372.67
CCH-6640-A	746163	1209306	8365.31
CCH-6640-B	745262	1209016	8375.97
CCH-6640-C	745992	1209275	8377.00
CCH-6650-A	745927	1208945	8365.41
CCH-6660-C	746111	1208839	8366.78
CCH-6680-A	746222	1208542	8367.13
CCH-6600-C	745819	1208529	8375.66
CCH-6670-A	746187	1208388	8362.47
CCH-6670-B	745922	1208367	8365.72
CCH-6370-C	745966	1208352	8374.39
CCH-6680-A	746167	1208149	8362.08
CCH-6680-B	745454	1208232	8370.18
CCH-6680-C	746001	1208110	8375.73
CCH-6300-A	746265	1208006	8361.63
CCH-6680-B	745035	1207934	8372.22
CCH-6680-C	745404	1208054	8367.11
CCH-6700-A	746268	1207852	8365.18
CCH-6700-C	746371	1207891	8361.21
CCH-6710-A	745318	1207809	8361.24
CCH-6710-B	745854	1207651	8368.89
CCH-6710-C	745934	1207542	8371.32
CCH-6720-A	746190	1207425	8366.60
CCH-6720-B	745068	1207461	8375.44
CCH-6720-C	745315	1207291	8370.52
CCH-6720-D	745274	1207278	8366.46
CCH-6730-A	746166	1207240	8369.73
CCH-6730-B	745414	1207184	8365.84
CCH-6730-C	746018	1207274	8367.36
CCH-6740-A	745184	1207132	8369.39
CCH-6740-C	746062	1207109	8372.34
CCH-6750-A	745184	1206925	8369.33
CCH-6750-B	745440	1206818	8369.89
CCH-6750-C	745879	1206983	8365.84
CCH-6730-D	745110	1206918	8355.77
CCH-6760-A	745169	1206846	8358.15
CCH-6760-B	745825	1206789	8365.92
CCH-6760-C	745840	1206571	8372.78
CCH-6770-A	745884	1206555	8367.46
CCH-6770-B	745798	1206576	8365.18
CCH-6770-C	746082	1206436	8361.82
CCH-6770-D	745982	1206626	8367.88
CCH-6770-E	745867	1206506	8369.96
CCH-6780-A	746673	1206446	8358.08
CCH-6780-C	745879	1206419	8358.53
CCH-6790-A	745754	1206281	8367.87
CCH-6790-B	746708	1206298	8362.38
CCH-6680-C	746820	1206123	8365.83
CCH-6690-A	746743	1205976	8367.96
CCH-6690-C	746551	1206001	8365.46
CCH-5610-A	745998	1205922	8358.34
CCH-5610-B	745722	1206892	8364.28
CCH-5610-C	745858	1205872	8362.38
CCH-5620-A	745854	1206280	8365.42
CCH-5630-B	745578	1205908	8361.81
CCH-5620-C	746472	1206080	8359.71
CCH-5630-A	746419	1205884	8363.08
CCH-5630-C	745398	1205920	8357.46
CCH-5640-A	745304	1206678	8358.81
CCH-5640-C	746242	1205787	8360.80
CCH-5650-A	746178	1206407	8364.08
CCH-5650-B	745510	1205836	8359.78
CCH-5660-C	746049	1205927	8375.18
CCH-5650-A	745918	1205342	8364.18
CCH-5650-B	745511	1205381	8365.39
CCH-5650-C	745098	1205191	8357.64
CCH-5660-D	746277	1206281	8363.50
CCH-5670-A	746253	1205147	8368.69
CCH-5670-C	746525	1205195	8363.70
CCH-5680-A	745423	1204801	8362.83
CCH-5680-B	746250	1204830	8360.90
CCH-5680-C	745806	1204877	8365.21
CCH-5690-A	745830	1204725	8363.48
CCH-5690-B	746397	1204668	8356.08
CCH-5690-C	746509	1204778	8365.62
CCH-6080-A	745689	1204952	8362.89
CCH-5900-C	745259	1204672	8364.04
CCH-6910-A	746842	1204399	8361.39
CCH-5910-B	745468	1204323	8356.08
CCH-5910-C	745724	1204398	8364.84
CCH-6080-A	746923	1201804	8348.84
CCH-6000-C	746467	1201826	8360.78
CCH-6050-C	746347	1201774	8358.80
CCH-6050-A	746371	1201737	8346.48
CCH-6600-C	746288	1201720	8342.20
CCH-6670-A	746424	1201682	8346.89
CCH-6670-C	746287	1201833	8348.86
CCH-6080-A	746460	1201428	8346.44
CCH-6090-C	746263	1201391	8355.38
CCH-6000-A	746479	1201263	8344.34
CCH-6680-C	746389	1201273	8340.35
CCH-6190-A	746571	1201169	8346.84
CCH-6190-C	746334	1201108	8346.72
CCH-6110-A	746527	1201049	8345.38
CCH-6110-C	746460	1201000	8339.25
CCH-6120-A	746930	1200908	8346.06
CCH-6130-C	746468	1200879	8355.80
CCH-6130-A	746884	1200778	8355.65
CCH-6130-B	746930	1200695	8344.86
CCH-6130-C	746514	1200741	8346.03
CCH-6140-A	746864	1200618	8357.66
CCH-6140-B	746701	1200636	8343.46
CCH-6140-C	746580	1200557	8346.29
CCH-6150-A	746848	1200336	8341.06
CCH-6150-C	746733	1200297	8342.46
CCH-6160-A	746929	1200274	8338.21
CCH-6160-C	746875	1200213	8342.01
CCH-6170-A	747061	1199950	8365.69
CCH-6120-C	746953	1199953	8342.36
CCH-6180-A	747123	1199932	8336.77
CCH-6180-C	747037	1199818	8341.36
CCH-6190-A	747114	1199549	8336.85
CCH-6190-C	747041	1199362	8340.84

Survey Control Station	Northing	Easting	Elevation
CCH-6200-A	747008	1199067	8340.81
CCH-6200-C	746953	1199106	8336.91
CCH-6210-A	746971	1199069	8341.86
CCH-6210-C	746962	1199001	8337.22
CCH-6220-A	746927	1198870	8336.31
CCH-6220-B	746982	1198837	8336.30
CCH-6220-C	746943	1198890	8335.73
CCH-6230-B	746924	1198800	8334.36
CCH-6230-C	746753	1198727	8333.40
CCH-6240-A	746972	1198418	8333.89
CCH-6240-C	746783	1198439	8330.51
CCH-6250-A	746729	1198207	8326.30
CCH-6250-B	746805	1198185	8333.38
CCH-6250-C	746510	1198274	8333.39
CCH-6260-B	746784	1198092	8332.87
CCH-6270-C	746390	1198062	8332.80
CCH-6260-D	746584	1198023	8329.53
CCH-6270-A	746838	1197940	8328.19
CCH-6270-C	746541	1197861	8328.70
CCH-6280-A	746581	1197856	8327.89
CCH-6280-B	746750	1197706	8331.97
CCH-6280-C	746390	1197886	8331.86
CCH-6290-A	746563	1197438	8328.12
CCH-6290-B	746729	1197489	8332.56
CCH-6290-C	746281	1197417	8327.93
CCH-6290-D	746496	1197461	8328.82
CCH-6680-A	746678	1197378	8328.89
CCH-6680-C	746529	1197257	8324.17
CCH-6310-B	746780	1197263	8332.04
CCH-6310-C	746525	1196985	8330.61
CCH-6320-C	746952	1197043	8325.36

LEGEND

- Culvert
- Trees or Shrubs
- Utility Pole
- P — Pipeline
- Fence
- Railroad
- Surface Water
- Building
- Sewage Sludge Line (8")
- Gas Line
- Sanitary Sewer Line
- Water Line
- Buried Telephone/Fiber Optic Line
- Stream Edge
- Creek/Drainage
- Road - Paved
- Road - Dirt/Gravel
- Road - Unimproved

ABBREVIATIONS

ARCO - Atlantic Richfield Company
BA - Borrow Area
C.Y - Cubic Yards
DIA - Diameter
FT - Feet
HDPE - High Density Polyethylene
IAW - In Accordance With
MBMG - Montana Bureau of Mines and Geology
MIN - Minimum
MPC - Montana Power Company
MWRR - Mine Waste Relocation Repository
NAD - North American Datum
NAVD - North American Vertical Datum
RI/FS - Remedial Investigation/Feasibility Study
RR - Railroad
S.F - Square Feet
SHT - Sheet

NOTES

1. Stream and Base topography provided by Horizon Inc., 1996. Two foot contour interval presented in feet above mean sea level (MSL). Other base features provided by Horizon Inc., 1989/1991.

2. Locations of all existing utilities, railroads, highways, wells and other structures shown are approximate and based on the best available information. Some existing utilities and structures may be missing on these plans. The contractor shall verify and locate all utilities and structures prior to commencement of work.

3. Control points were established by Clear Creek Hydrology Survey, 1997.

REV	DATE	DESCRIPTION	DRN BY	APP BY

Date: June 16, 1999
Project #: 6304-485.700
File: S:\Projects\Final Design\Final Design\Second Design Phase\Drawings\Sheet M2 - General Legend and Notes.dwg

MAXIM TECHNOLOGIES INC

Project Title: Final Design
Streamside Tailings Operable Unit
Silver Bow Creek - Subarea I - Reach A

Sheet Title: General Legend And Notes

SHEET M2

LEGEND

- Primary Haul Roads For Use By Off-Road Haul Trucks
- Primary Haul Road For Use By On-Road Haul Truck-(road improvement may be necessary)
- BA-10 — Borrow Boundary to be Remediated
- MWRR-2 — Tailings Repository Boundary for RR Materials
- Railroad Materials
- * SB-S4 — Sediment Basins
- Staging Area
- Diversion Channel
- Limits of Disturbance

Horizontal Extent Of Tailings/Impacted Soil Line Provided In Electronic Format By ARCO And Modified By Maxim Technologies Based On Field Verification Completed In November 1997.

N

0 300 600
Feet

No.	DATE	DESCRIPTION	DRN BY	APP BY

Date: June 18, 1999
Project #: 6660460.700
File: g:\cad\arcad\dgn\sed_plan\sp7plan1sb.dgn

Final Design
Streamside Tailings Operable Unit
Silver Bow Creek - Subarea I - Reach A

MAXIM TECHNOLOGIES INC

General Site Plan
SHEET M3

Pole To Be Removed (Not In This Contract)

MW-104

6411.82

5410.66

5414.24

5418.83

GS-27S

5414.44

GS-27D

GT-84-7

MATCH LINE

Upper End Of Streamside Tailings Operable Unit Subarea I Reach A

Lower End Of Lower Area One

LEGEND

5432.21 ■ Test Pit Location And Elevation At Base Of Tailings/Impacted Soil Provided By ARCO In Electronic Format. Test Pits with Zero Tailings Outside The Horizontal Extent Are Not Shown. Test Pits Excavated In 1996 And 1997 According To Procedures Outlined In The "Comprehensive Remedial Design Sampling And Analysis Plan", ARCO, October, 1996

VS-1 ▲ Verification Horizontal Extent Sample Locations. Sample Pits Excavated In 1997 By Maxim Technologies According To The "Sampling And Analysis Plan Addendum, Draft Final", January 1998. Sample Locations Surveyed Using Global Positioning System Instrumentation.

Horizontal Extent Of Tailing/Impacted Soil Line Provided In Electronic Format By ARCO And Modified By Maxim Technologies Based On Field Verification Completed In November 1997

■ Existing Monitoring Well

□ Existing Piezometer

N

0 100 200
Feet

REV.	DATE	DESCRIPTION	DRN BY	APP BY

Date June 16, 1998

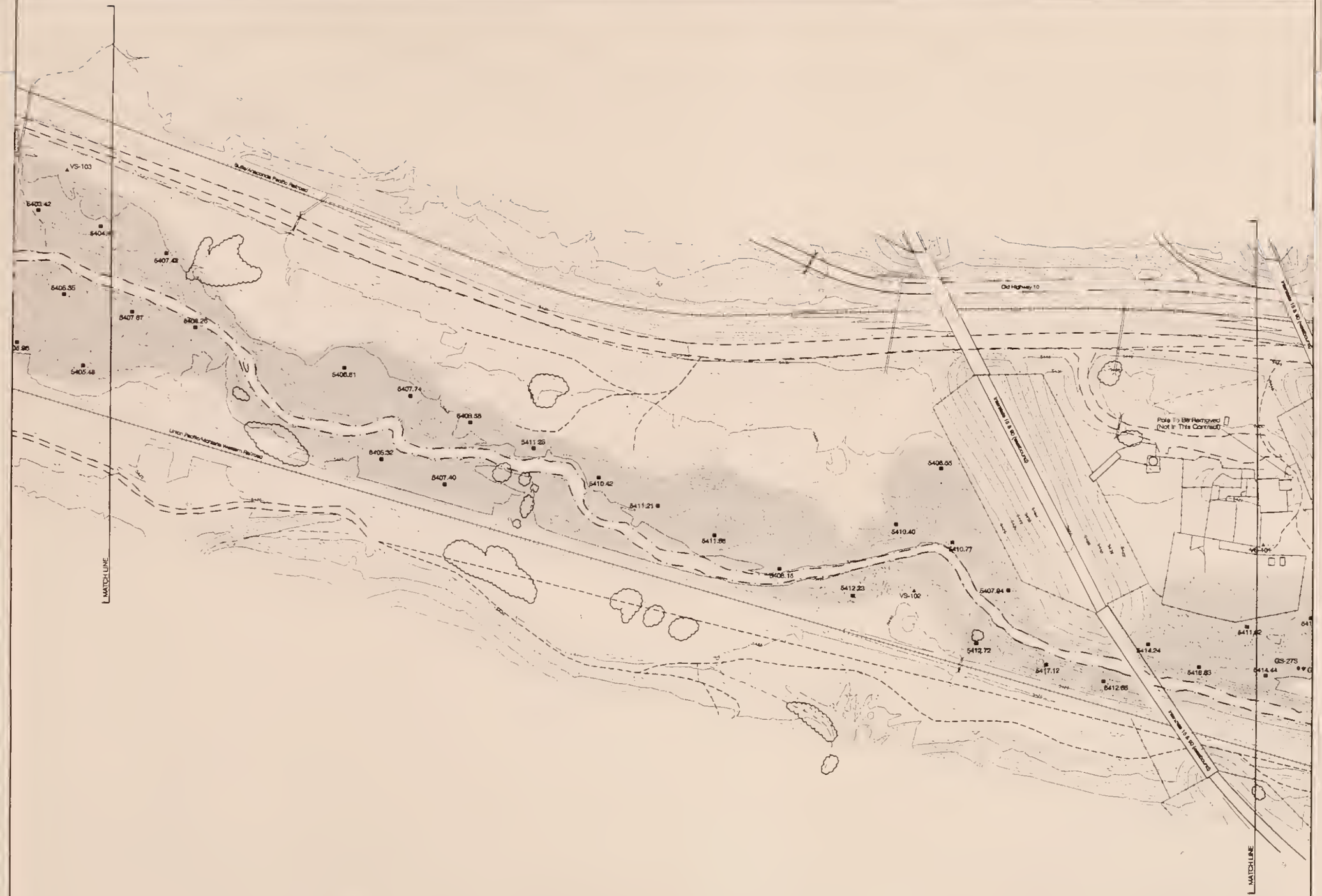
Project # 9000-440.700

File g:\projects\cad\gmsheet-accordex-scn3.dwg

Final Design
Streamside Tailings Operable Unit
Silver Bow Creek - Subarea I - Reach A

MAXIM TECHNOLOGIES INC

Existing Conditions
SHEET M4a



LEGEND

5432.21 ■ Test Pit Location And Elevation At Base Of Tailings/Impacted Soil Provided By ARCO In Electronic Format. Test Pits with Zero Tailings Outside The Horizontal Extent Are Not Shown; Test Pits Excavated In 1996 And 1997 According To Procedures Outlined In The "Comprehensive Remedial Design Sampling And Analysis Plan", ARCO, October, 1996.

VS-1 ▲ Verification Horizontal Extent Sample Locations. Sample Pits Excavated In 1997 By Maxim Technologies According To The "Sampling And Analysis Plan Addendum, Draft Final", January 1996. Sample Locations Surveyed Using Global Positioning System Instrumentation.

Horizontal Extent Of Tailing/Impacted Soil. Line Provided In Electronic Format By ARCO And Modified By Maxim Technologies Based On Field Verification Completed In November 1997.

● Existing Monitoring Well

○ Existing Piezometer

N

0 100 200
Feet

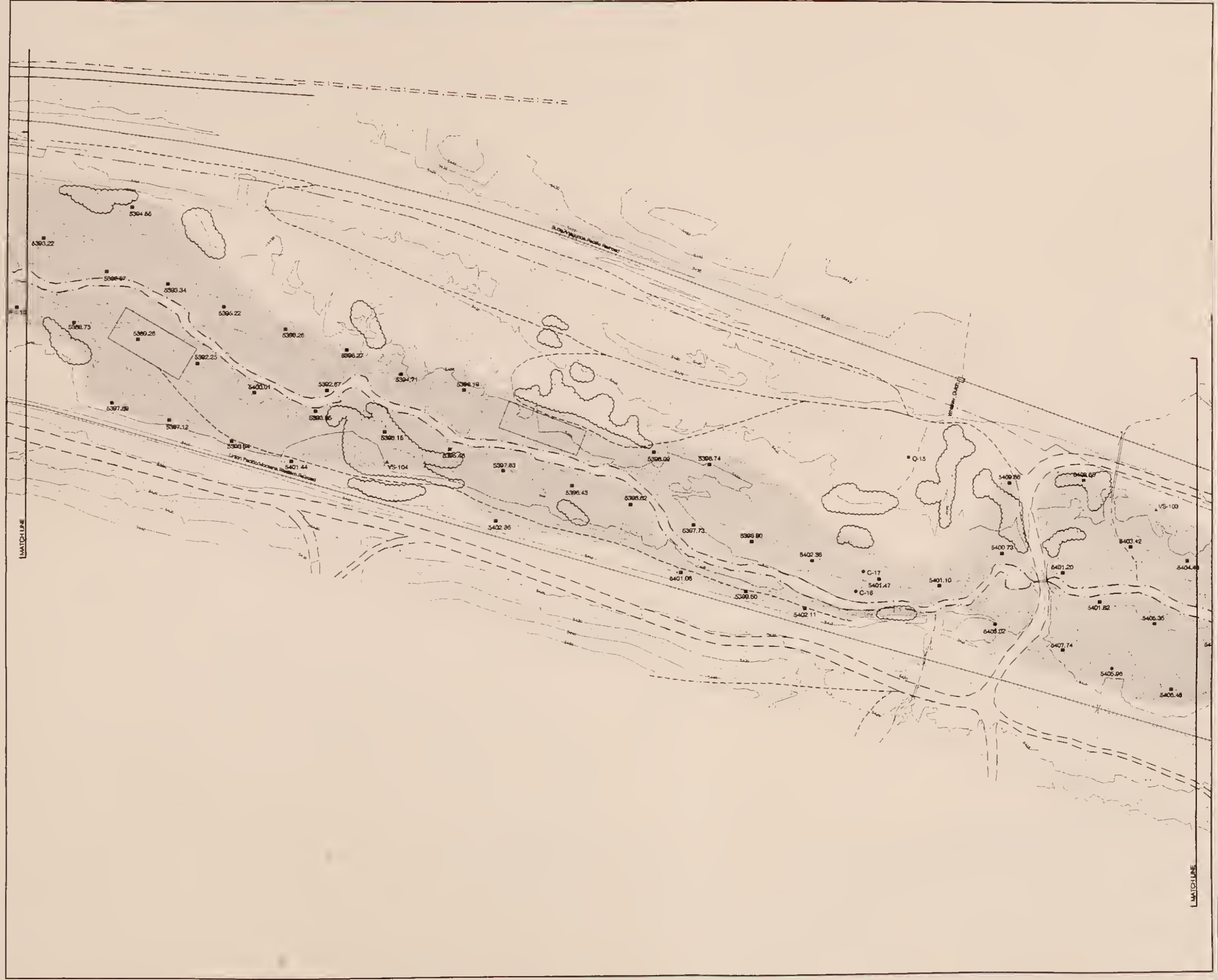
REV'S	DATE	DESCRIPTION	DRN. BY	APP. BY

Date: APR 16, 1998
Project #: 5555-483.100
File: c:\projects\arco\design\sheets\cmd-sht4.dwg

Project Title: Final Design
Streamside Tailings Operable Unit
Silver Bow Creek - Subarea I - Reach A

MAXIM TECHNOLOGIES INC

Sheet Title: Existing Conditions
SHEET M4b



LEGEND

5432.21 ■ Test Pit Location And Elevation At Base Of Tailings/Impacted Soil Provided By ARCO In Electronic Format. Test Pits with Zero Tailings Outside The Horizontal Extent Are Not Shown. Test Pits Excavated In 1996 And 1997 According To Procedures Outlined In The "Comprehensive Remedial Design Sampling And Analysis Plan", ARCO, October, 1995

VS-1 ▲ Verification Horizontal Extent Sample Locations. Sample Pits Excavated In 1997 By Maxim Technologies According To The "Sampling And Analysis Plan Addendum, Draft Final", January 1998. Sample Locations Surveyed Using Global Positioning System Instrumentation.

Horizontal Extent Of Tailing/Impacted Soil Line Provided In Electronic Format By ARCO And Modified By Maxim Technologies Based On Field Verification Completed In November 1997

● Existing Monitoring Well

□ Existing Piezometer

N

0 100 200
Feet

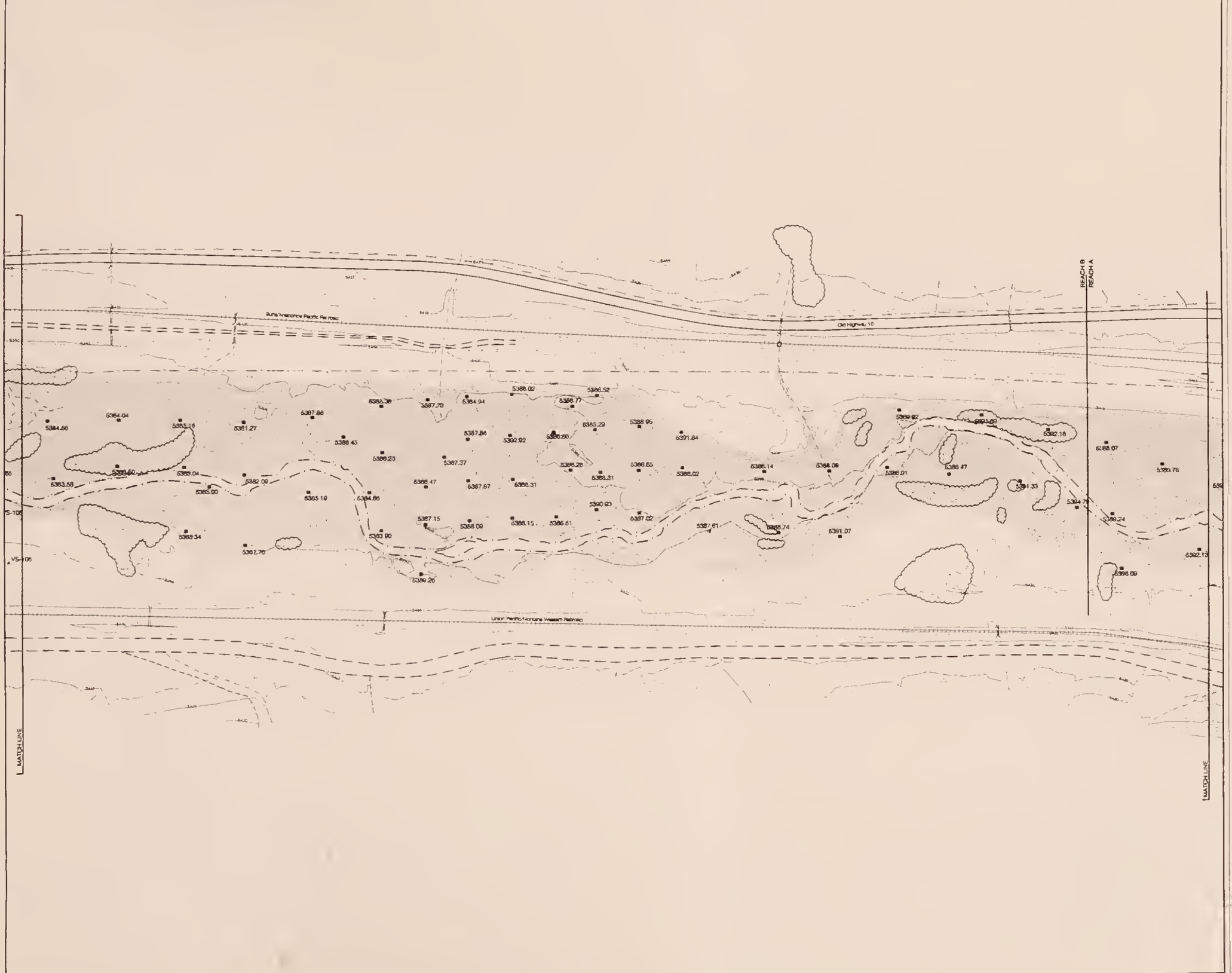
REV	DATE	DESCRIPTION	DRN BY	APP BY

Date: June 18, 1998
Project #: 5953-08.700
File: g:\projects\arco\figures\accordion-sht4.dwg

Final Design
Streamside Tailings Operable Unit
Silver Bow Creek - Subarea I - Reach A

MAXIM TECHNOLOGIES INC

Existing Conditions
SHEET M-4c



LEGEND

5432.21 ■ Test Pit Location And Elevation At Base Of Tailings/Impacted Soil Provided By ARCO In Electronic Format. Test Pits with Zero Tailings Outside The Horizontal Extent Are Not Shown. Test Pits Excavated In 1996 And 1997 According To Procedures Outlined In The "Comprehensive Remedial Design Sampling And Analysis Plan", ARCO, October, 1996

VS-1 ▲ Verification Horizontal Extent Sample Locations. Sample Pits Excavated In 1997 By Maxim Technologies According To The "Sampling And Analysis Plan Addendum, Draft Final", January 1998. Sample Locations Surveyed Using Global Positioning System Instrumentation

Horizontal Extent Of Tailing/Impacted Soil Line Provided In Electronic Format By ARCO And Modified By Maxim Technologies Based On Field Verification Completed In November 1997

● Existing Monitoring Well

□ Existing Piezometer

REV	DATE	DESCRIPTION	DRN BY	APP BY

Date: June 16, 1998
Project #: 6868-499.700
File: g:\projects\arco\figures\existcon-rch1.dwg

Project Title: Final Design
Streamside Tailings Operable Unit
Silver Bow Creek - Subareas I - Reach A

MAXIM TECHNOLOGIES INC

Sheet Title: Existing Conditions
SHEET M4d

NOTES

1. Coordinate grid on 100' intervals using project datum based on Montana State Plane Coordinate System, South Zone, NAD 27. Elevations are North American Vertical Datum 1929.

2. Master lime application rate of 29 tons of effective calcium carbonate equivalent per 1000 tons of tailings/impacted soils applies to all removed materials without special lime application rates.

LEGEND

Horizontal Extent Of Tailings Impacted Soil Line Provided In Electronic Format By ARCO And Modified By Maxim Technologies Based On Field Verification Completed In November 1997.

CCH-6123 ▲ Survey control points from a survey performed by DJ&A for ARCO in 1997. See Sheet M2 for coordinate information.

■ Staking points where saturated materials may be encountered in tailings/impacted soil excavation. See Sheet M5e for coordinate information.

● Staking points where saturated material is not expected to be encountered in tailings/impacted soil excavation. See Sheet M5e for coordinate information.

◆ Additional staking points required for construction of finished grade. See Sheet M5e for coordinate information.

LAA-1 42 t/1000 t — Special lime application areas (LAA's). Rates specified in tons of effective calcium carbonate equivalent per 1000 tons of tailings/impacted soil.

Areas where final grade is below tailings/impacted soil grade.

N

0 100 200
Feet

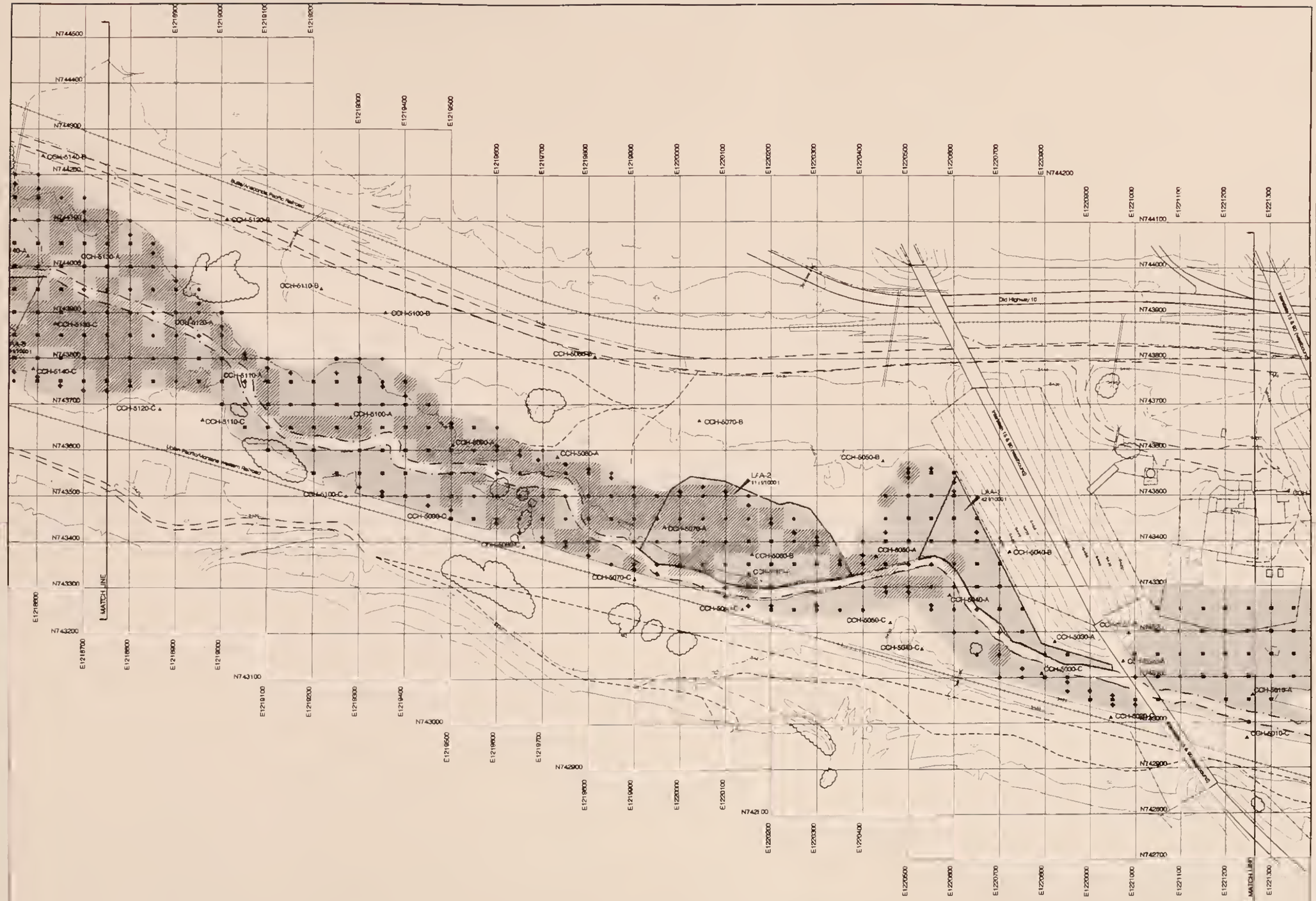
No.	DATE	DESCRIPTION	DRN BY	APP BY

Date: June 14, 1999
Project #: 5800-610.700
File: g:\projects\arco\upgrade_design\plates\m5a.dwg

Final Design
Streamside Tailings Operable Unit
Silver Bow Creek - Subarea I - Reach A

MAXIM TECHNOLOGIES INC

Staking Plan
SHEET M5a



NOTES

1. Coordinate grid on 100' intervals using project datum based on Montana State Plane Coordinate System, South Zone, NAD 27. Elevations are North American Vertical Datum 1929.

2. Master lime application rate of 29 tons of effective calcium carbonate equivalent per 1000 tons of tailings/impacted soils applied to all removed materials without special lime application rates

LEGEND

Horizontal Extent Of Tailings Impacted Soil Line Provided In Electronic Format By ARCO And Modified By Maxim Technologies Based On Field Verification Completed In November 1997

CCH-6120 — Survey control points from survey performed by DJ&A for ARCO in 1997. See Sheet M2 for coordinate information.

- Staking points where saturated materials may be encountered in tailings/impacted soil excavation. See Sheet M5e for coordinate information.
- Staking points where saturated material is not expected to be encountered in tailings/impacted soil excavation. See Sheet M5e for coordinate information
- Additional staking points required for construction of finished grade. See Sheet M5e for coordinate information.

LAA-1 42 l/1000 l — Special lime application areas (LAA's). Rates specified in tons of effective calcium carbonate equivalent per 1000 tons of tailings/impacted soil

Areas where final grade is below tailings/impacted soil grade

N

0 100 200 Feet

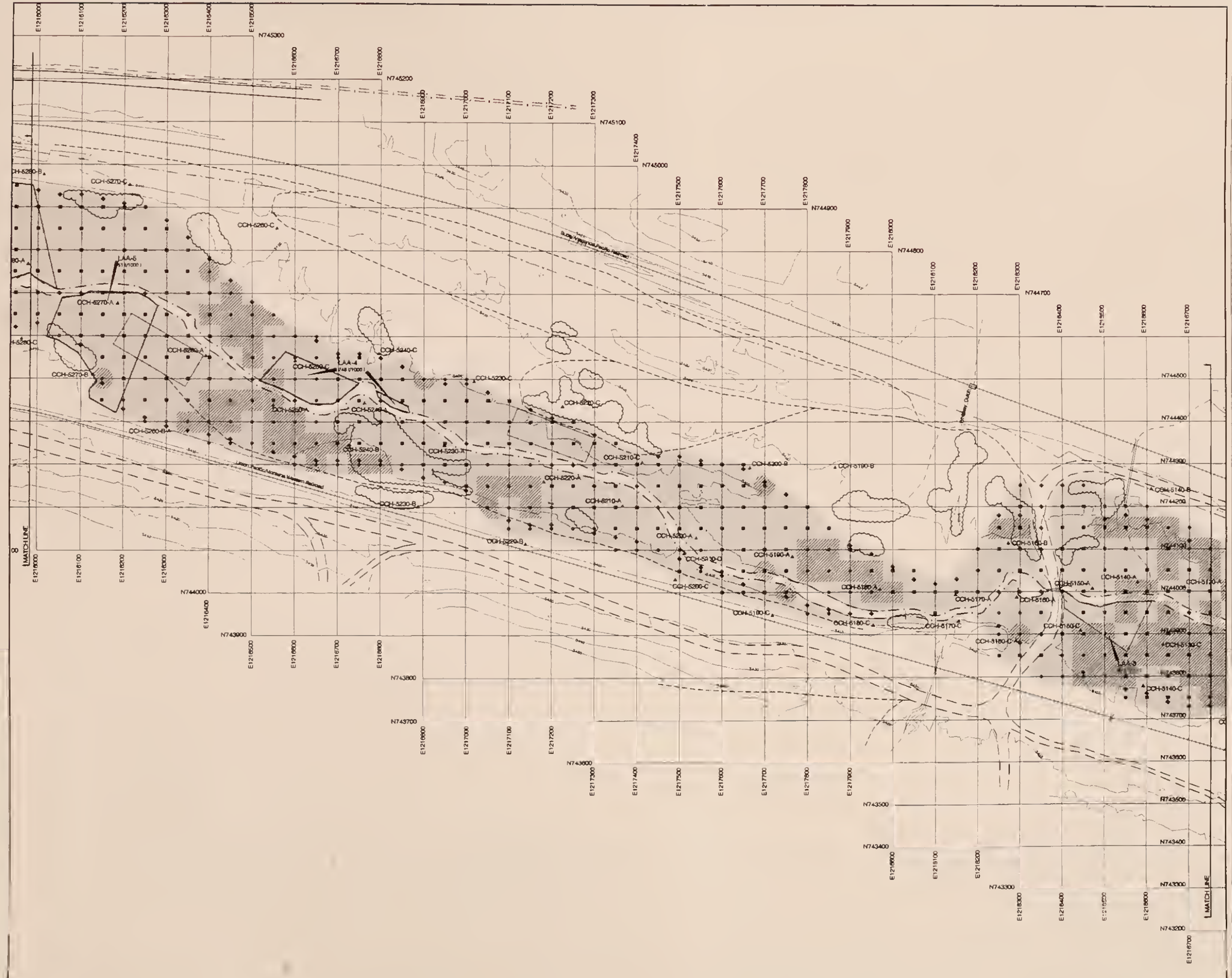
REV	DATE	DESCRIPTION	DRN BY	APP BY

Date: June 16, 1999
Project # 98E0455.700
File: g:\mt\billings\work\acad\projects\arco\silver_bow_creek\sheets\m5e.dwg

Project Title: Final Design
Streamside Tailings Operable Unit
Silver Bow Creek - Subarea I - Reach A

Sheet Title: Staking Plan
SHEET M5e

MAXIM TECHNOLOGIES INC



NOTES

1. Coordinate grid on 100 intervals using project datum based on Montana State Plane Coordinate System, South Zone, NAD 27. Elevations are North American Vertical Datum 1929.

2. Master lime application rate of 29 tons of effective calcium carbonate equivalent per 1000 tons of tailings/impacted soils applies to all removed materials without special lime application rates

LEGEND

Horizontal Extent Of Tailings Impacted Soil Line Provided In Electronic Format By ARCO And Modified By Maxim Technologies Based On Field Verification Completed In November 1997

CCH-6123 ▲ Survey control points from survey performed by DJ&A for ARCO in 1997. See Sheet M2 for coordinate information.

■ Staking points where saturated materials may be encountered in tailings/impacted soil excavation. See Sheet M5e for coordinate information.

● Staking points where saturated material is not expected to be encountered in tailings/impacted soil excavation. See Sheet M5e for coordinate information.

◆ Additional staking points required for construction of finished grade. See Sheet M5e for coordinate information.

LAA-1 42 t/1000 t — Special lime application areas (LAA's). Rates specified in tons of effective calcium carbonate equivalent per 1000 tons of tailings/impacted soil

Areas where final grade is below tailings/impacted soil grade.

N

0 100 300
Feet

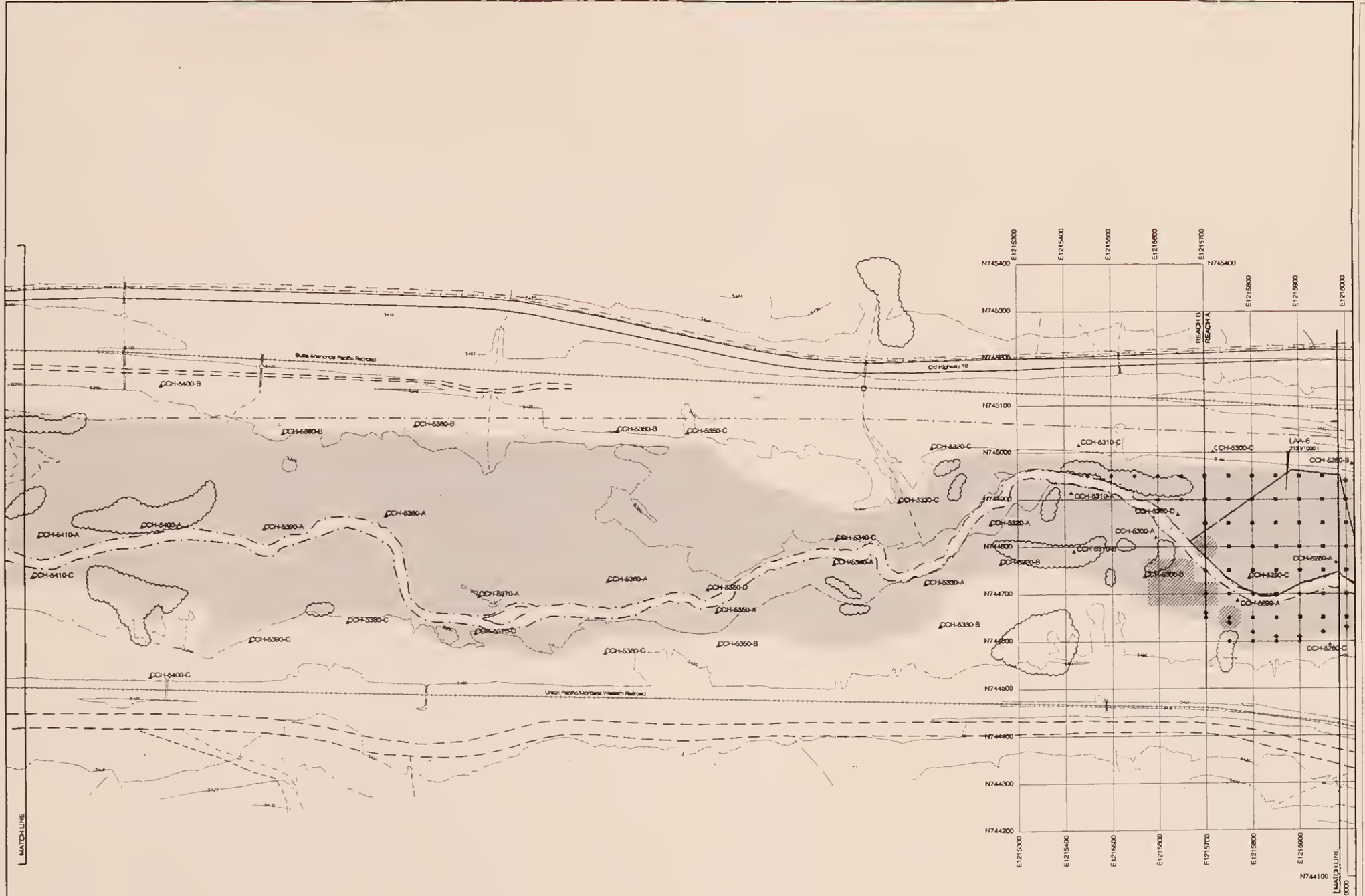
REV	DATE	DESCRIPTION	DRN BY	APP BY

DATE: JUNE 18, 1999
PROJECT #: 9880-485.700
FILE: g:\projects\final_design\sheet_staking\m5c.dwg

Final Design
Streamside Tailings Operable Unit
Silver Bow Creek - Subareas I - Reach A

Staking Plan
SHEET M5c

MAXIM TECHNOLOGIES INC



NOTES

1. Coordinate grid on 100' intervals using project datum based on Montana State Plane Coordinate System, South Zone, NAD 27. Elevations are North American Vertical Datum 1929.

2. Master lime application rate of 29 tons of effective calcium carbonate equivalent per 1000 tons of tailings/impacted soils applies to all removed materials without special lime application rates.

LEGEND

Horizontal Extent Of Tailings Impacted Soil Line Provided In Electronic Format By ARCO And Modified By Maxim Technologies Based On Field Verification Completed In November 1997

CCH-6240 ▲ Survey control points from survey performed by DJ&A for ARCO in 1997. See Sheet M2 for coordinate information.

■ Staking points where saturated materials may be encountered in tailings/impacted soil excavation. See Sheet M5e for coordinate information.

● Staking points where saturated material is not expected to be encountered in tailings/impacted soil excavation. See Sheet M5e for coordinate information.

◆ Additional staking points required for construction of finished grade. See Sheet M5e for coordinate information.

LAA-1 / 42 lb/1000 t — Special lime application areas (LAA's). Rates specified in tons of effective calcium carbonate equivalent per 1000 tons of tailings/impacted soil.

Areas where final grade is below tailings/ impacted soil grade.

N

0 100 200
Feet

REV	DATE	DESCRIPTION	CHK'D BY	APP'D BY

Date: June 18, 1998
Project # 5800-60.100
File: g:\projects\arco\dwg\mod\staking\staking.dwg

Final Design
Streamside Tailings Operable Unit
Silver Bow Creek - Subarea I - Reach A

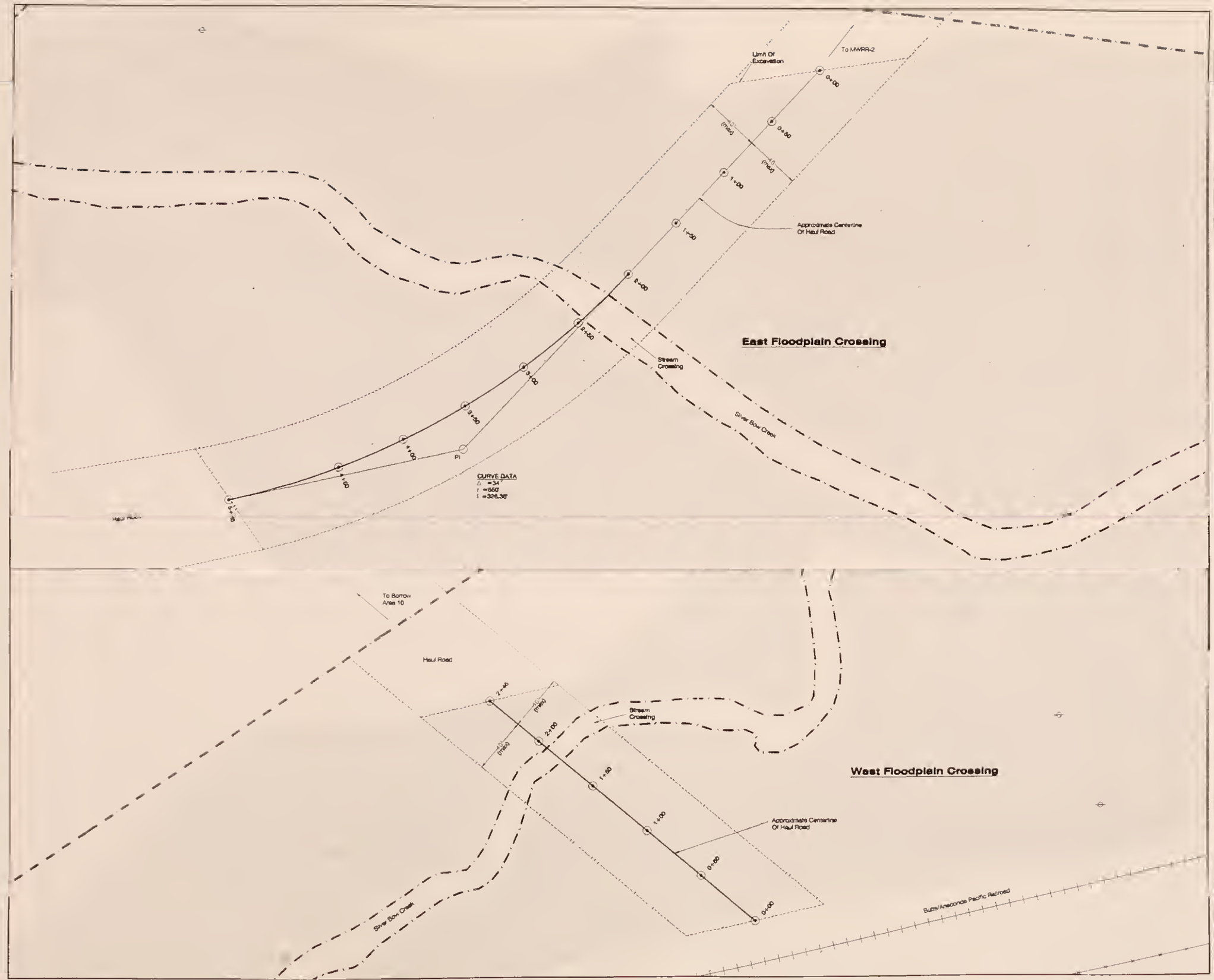
MAXIM TECHNOLOGIES INC

Staking Plan
SHEET M6d

Easting	Northing	Tailings/ Impacted Soils Excavation Grade	Groundwater	Final Grade
1215450	744600	5382.81	5390.00	5394.00
1215600	744600	5387.21	5390.00	5394.80
1215408	744000	5391.43	5390.00	5394.80
1215800	744600	5391.82	5389.80	5398.00
1215800	744200	5391.43	5390.00	5398.00
1216000	744000	5390.80	5391.00	5395.00
1216000	744200	5392.70	5396.40	5392.60
1216700	744600	5393.03	5392.10	5394.80
1216450	744600			5394.80
1216700	744600			5395.80
1216700	744700	5392.86	5391.00	5392.70
1216700	744800			5391.00
1216700	744000	5391.19	5389.00	5387.70
1216700	744000	5389.24	5390.80	5387.70
1216700	744600	5389.41	5390.40	5394.20
1215750	744600	5394.37	5388.90	5388.00
1216750	744640			5392.90
1216700	744600	5392.88	5391.70	5392.80
1216700	744700	5392.86	5390.80	5392.80
1215750	744700	5389.41	5800.40	5391.80
1216700	744600	5389.40	5390.40	5387.70
1216700	744600	5388.86	5800.00	5394.20
1216700	744600	5387.81	5391.10	5800.00
1216750	744600	5389.40	5392.20	5394.70
1216800	744810			5396.50
1216800	743850	5382.21	5387.80	5392.00
1216800	744700	5390.80	5391.60	5800.40
1216800	744700	5389.78	5391.40	5392.00
1216850	743400	5389.22	5391.40	5391.00
1215850	743400	5388.88	5391.50	5392.40
1216903	744400	5389.78	5391.00	5392.00
1216850	744350	5389.12	5392.80	5392.80
1216900	744600	5389.41	5391.00	5395.00
1216962	744810			5396.40
1216962	744600	5391.95	5392.30	5396.00
1216962	744700			5387.90
1215900	744730	5390.46	5392.00	5392.40
1216962	744600	5390.04	5387.80	5392.40
1216962	744850	5388.78	5391.90	5392.00
1216962	744600	5389.73	5392.80	5393.30
1216962	744600	5389.85	5389.30	5396.50
1215800	744850			5396.80
1216962	744850	5391.71	5388.00	5392.00
1216962	744700	5391.27	5392.00	
1216950	744700	5391.27	5391.00	5800.40
1216962	744600	5391.00	5392.00	5392.40
1215940	744850	5390.86	5800.20	5395.40
1216968	744600	5800.79	5392.00	5393.90
1216930	744650	5390.86	5389.80	5396.20
1216950	744600			5396.70
1216950	744850	5391.00	5392.10	5388.00
1216950	744700	5391.13	5392.00	5391.80
1216900	744750	5391.54	5392.30	5395.00
1216950	744600	5392.27	5800.40	5396.40
1216962	744650	5391.87	5396.80	5393.90
1216968	744650	5391.87	5396.80	5394.80
1216900	744640		5396.00	5394.80
1216950	744600	5393.80	5800.40	5800.00
1216950	744700	5391.71	5392.30	5393.80
1216000	744600	5392.55	5392.30	5800.80
1216000	743850	5392.81	5393.00	5394.80
1216000	744020	5392.36	5800.80	5394.80
1216100	744600			5395.20
1216100	744600	5395.49	5395.20	5397.20
1216100	744600	5395.36	5394.80	5392.36
1216100	744600	5392.18	5800.80	5394.20
1216100	743400	5388.37	5391.10	5393.80
1216100	744600	5388.82	5392.70	
1216100	744700	5380.86	5800.80	5393.20
1216100	744700	5392.41	5395.80	5395.80
1216100	744400	5391.06	5394.40	5394.80
1216093	743400	5393.84	5391.30	5394.80
1216000	744600	5392.74	5389.10	5395.80
1215200	744810			5399.70
1215750	743400	5395.59	5396.80	5800.00
1215750	744410			5396.00
1216300	743400	5394.75	5396.80	5398.40
1216700	744020	5800.24	5394.00	5394.00
1216250	743400	5389.78	5395.00	5393.80
1216250	743400	5800.24	5396.00	5395.80
1216250	744600	5380.38	5393.80	
1216250	744700			5395.80
1216250	744700	5394.80	5396.00	5394.10
1215250	743450	5393.35	5394.80	5394.80
1216250	743400	5394.84	5396.00	5394.10
1216750	744600	5394.04	5391.80	5800.00
1216000	744360			5396.40
1216000	744400	5394.17	5393.70	5397.00
1216000	744400	5394.38	5393.10	5399.00
1216000	744000	5392.17	5394.80	5396.80
1216000	744000	5389.58	5394.00	5396.80
1216000	744600	5389.30	5394.00	5396.00
1216000	744030	5391.25	5394.80	5392.10
1216000	744700	5392.39	5394.00	5394.10
1216000	744700	5800.14	5394.80	5394.80
1216000	743400	5396.30	5396.00	5396.00
1216302	744000	5394.85	5396.00	5394.80
1216000	744870			5392.80
1216800	744380			5897.10
1216350	743400	5396.80	5395.70	5396.30
1216302	744400	5394.17	5392.00	5394.80
1216980	743400	5392.35	5394.40	5394.80
1216980	744000	5391.85	5394.00	5394.80
1216000	744000	5397.45	5396.00	
1216800	744700			5394.80
1216362	744780	5392.84	5394.30	5394.80
1216350	744400	5396.87	5800.70	5396.00
1216408	744400	5396.62	5394.80	5401.00
1216408	744370			5397.80
1216408	743400	5396.80	5393.80	5396.00
1216408	743400	5394.88	5394.80	5394.80

Easting	Northing	Tailings/ Impacted Soils Excavation Grade	Groundwater	Final Grade
1215498	744600	5392.30	5394.00	5393.80
1215498	744000	5392.83	5394.00	
1215400	744600	5392.43	5394.00	5392.40
1215498	744700	5800.87	5394.00	5394.70
1215498	744700	5395.77	5800.10	5800.80
1215498	744700			5800.80
1215405	744300	5393.80	5395.30	5390.70
1216450	744350			5397.00
1216450	744400	5396.88	5395.30	5394.80
1216450	744400	5395.19	5394.00	5394.00
1216408	744030	5395.01	5394.00	
1216450	744600	5394.23	5394.00	5395.80
1216450	744700	5396.11	5395.00	5394.80
1216450	744730	5394.35	5394.00	5394.80
1216500	744350	5397.20	5396.00	5397.40
1216600	743400	5397.84	5394.80	
1216600	744400	5396.36	5394.10	5396.00
1216000	744000			5395.30
1216600	744000	5395.85	5396.80	5397.00
1216600	744450	5393.49	5391.00	5397.70
1217000	744400			5800.70
1217300	744000	5399.88	5396.10	5401.70
1217300	744000	5396.29	5394.00	5397.00
1217050	744250	5397.80	5391.00	5397.00
1217300	744000	5395.31	5393.10	5397.40
1217300	744350	5396.00	5392.00	5397.70
1217050	743400	5398.53	5398.40	5397.00
1217050	744450	5396.66	5397.80	5800.70
1217050	744770			5408.80
1217100	744180	5401.80	5800.10	5404.60
1217100	744170			5800.80
1217100	743850	5399.88	5397.80	5397.80
1217100	744000	5396.81	5396.00	5397.70
1217100	744000	5405.81	5396.00	5397.70
1217100	743850	5399.98	5393.80	5396.20
1217100	744350	5398.74	5398.10	5397.70
1217700	743400	5396.66	5395.00	5405.00
1217150	744130	5405.10	5398.00	5401.80
1217150	744100			5800.40
1217180	743850	5398.89	5397.70	5397.10
1217150	744250	5397.64	5398.30	5397.20
1217180	744350	5398.88	5396.00	5397.80
1217180	744000	5398.18	5396.00	5397.80
1217100	743400	5398.81	5397.00	5800.10
1217180	744130			5397.80
1217300	744150	5399.88	5399.40	5401.10
1217300	744100			5800.00
1217300	743850	5397.81	5391.80	5397.40
1217300	744000	5396.93	5397.00	5800.00
1217300	744000			5396.80
1217300	744350	5398.88	5397.80	5397.80
1217300	744400	5398.10	5396.00	5396.00
1217300	744100			5397.80
1217250	744150	5398.99	5399.10	5401.00
1217300	744200	5399.89	5800.00	
1217250	744250	5399.17	5397.80	5397.80
1217350	744000			5800.40
1217280	744350	5399.88	5398.00	5398.00
1217280	744400	5396.85	5395.00	5398.40
1217300	744140			5401.70
1217300	744100	5399.00	5398.00	5800.00
1217300	743850	5408.45	5398.00	
1217300	744000	5399.98	5395.00	5398.40
1217300	744350	5800.04	5398.20	5402.88
1217300	744370			5401.40
1217350	744100	5401.57	5399.80	5405.80
1217800	744180			5401.40
1217350	744150	5397.60	5398.00	5396.20
1217350	743850	5396.29	5800.00	5396.20
1217800	743850	5405.10	5399.00	5399.70

Easting	Northing	Tailings/ Impacted Soils Excavation Grade	Groundwater	Final Grade
1217350	744000	5396.36	5398.40	5403.60
1217400	744100	5392.84	5800.10	5404.70
1217400	744120			5402.00
1217400	744000	5398.30	5396.00	5392.20
1217400	743400	5393.16	5398.00	5397.00
1217400	743400			5396.80
1217450	743400	5396.67	5396.30	5396.80
1217480	744100	5800.10	5396.30	5401.10
1217450	744150	5392.08	5396.00	5390.30
1217450	743400			5395.30
1217450	743400	5396.66	5800.10	5399.80
1217450	743400	5397.80	5395.40	5394.30
1217450	743400			5396.80
1217800	744000	5399.82	5400.80	5408.70
1217800	744000			5404.20
1217800	744100	5396.35	5396.00	5400.70
1217800	744100	5397.80	5396.00	
1217800	743850	5397.05	5396.80	5396.80
1217800	744000	5391.26	5396.30	5399.40
1217800	744100	5397.66	5396.30	5399.40
1217800	744000			5396.80
1217800	744350	5399.82	5396.30	5396.80
1217800	744000			5396.80
1217800	744000	5396.35	5396.00	5397.70
1217800	744000			5800.70
1217800	744000	5399.82	5400.60	5404.60
1217800	744000			5396.80
1217800	744100



East Floodplain Crossing

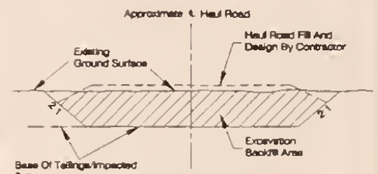
STATION	NORTHING	EASTING	TAILINGS/IMPACTED SOIL EXCAVATION GRADE	APPROXIMATE SURFACE ELEVATION	APPROX. CUT (FT)
0+00	745102.06	1212748.05	5385.8	5386.3	0.5
0+50	745085.67	1212713.85	5382.4	5386.3	3.9
1+00	745029.10	1212679.65	5382.0	5386.2	4.2
1+50	744982.63	1212645.46	5382.2	5385.6	3.0
2+00	744956.10	1212611.24	5381.8	5385.4	3.6
2+50	744921.29	1212575.43	5381.5	5384.9	3.4
3+00	744889.82	1212536.80	5381.4	5384.5	3.1
3+50	744862.00	1212495.07	5381.5	5384.3	2.8
4+00	744838.07	1212451.19	5381.8	5385.7	3.9
4+50	744810.22	1212406.32	5382.4	5384.6	2.2
5+26	744796.14	1212332.27	5384.1	5384.6	0.5

West Floodplain Crossing

STATION	NORTHING	EASTING	TAILINGS/IMPACTED SOIL EXCAVATION GRADE	APPROXIMATE SURFACE ELEVATION	APPROX. CUT (FT)
0+00	745764.98	1206481.23	5355.1	5358.9	3.8
0+50	745796.87	1206442.72	5354.7	5358.6	3.9
1+00	745828.75	1206404.20	5354.6	5358.3	3.8
1+50	745860.64	1206365.69	5354.4	5358.1	3.7
2+00	745892.53	1206327.18	5354.1	5357.9	3.8
2+45	745921.23	1206292.52	5357.3	5357.8	0.5

LEGEND

Horizontal Extent Of Tailings Impacted Soil. Line Provided In Electronic Format By ARCO And Modified By Maxim Technologies Based On Field Verification Completed In November 1997



Width To Be Determined By Contractor. Excavation Grade For Tailings/Impacted Soils Specified On Drawings

Typical Excavation Cross-Section
NTS

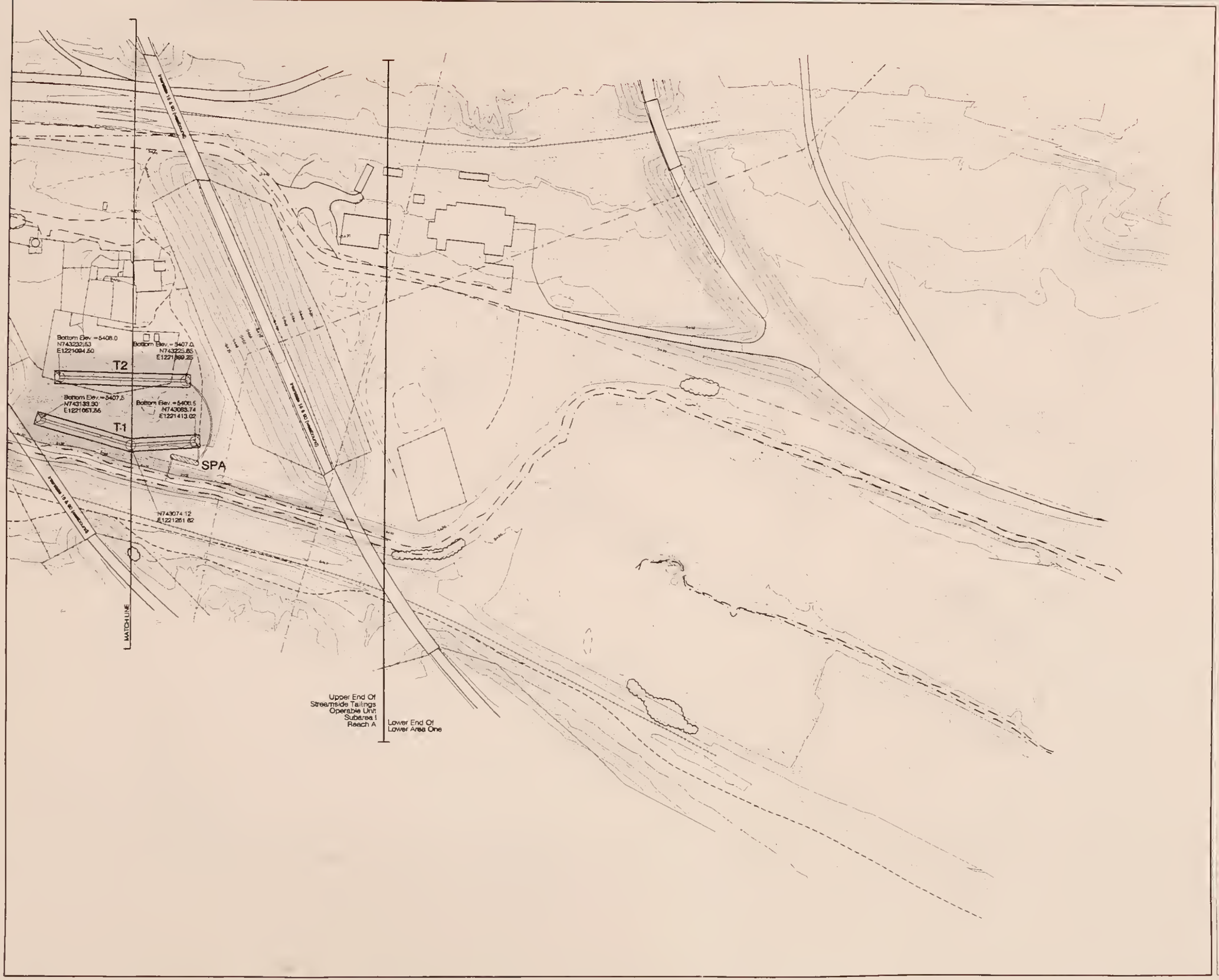
NO.	DATE	DESCRIPTION	DRN. BY	APP'D

Date: June 14, 1999

Project Title: Final Design
Streamside Tailings Operable Unit
Silver Bow Creek - Subarea I - Reach A

Drawing Title: Haul Road Staking Plan
Floodplain Crossings
SHEET M5

MAXIM TECHNOLOGIES INC



NOTES

1. Sediment Detention Pond Locations Shown on this Sheet are Approximate. The Engineer Shall Approve the Final Locations of the Ponds. See Sheet M6a for Specific Size Requirements for Each Pond. The Ponds Shall be this Size or Larger.

2. The Centerline of the Groundwater Dewatering Trenches T4, T5, T7, T10, T12, T13 Shall Follow the Centerline of the New Stream Channel.

LEGEND

T1 — Groundwater Dewatering Trench

SPA — General Detention Pond Locations

Trench Discharge Pipe

A+00 — Diversion Channel

1+00 — Reconstructed Channel Alignment with Downstream Stationing as Designed by Interfluve, Inc.

Horizontal Extent Of Tailings Impacted Soil. Line Provided In Electronic Format By ARCO And Modified By Maxim Technologies Based On Field Verification Completed In November 1997.

N

0 100 200
Feet

REV	DATE	DESCRIPTION	DRN BY	APP BY

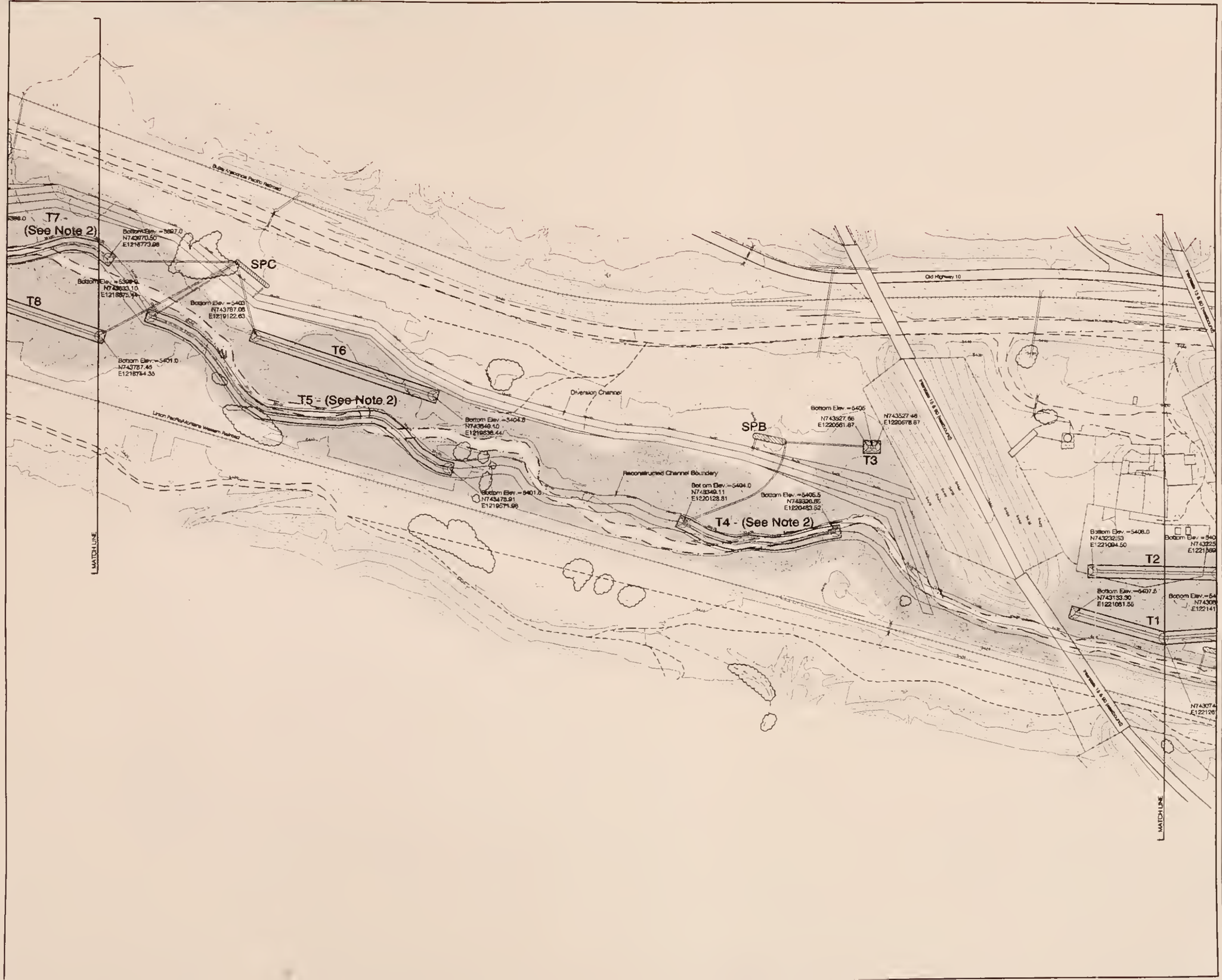
Date: June 18, 1998

Project # 8953-623.F00

MAXIM TECHNOLOGIES INC

Final Design
Streamside Tailings Operable Unit
Silver Bow Creek - Subarea I : Reach A

Groundwater Dewatering Plan
SHEET M6



NOTES

1. Sediment Detention Pond Locations Shown on this Sheet are Approximate. The Engineer Shall Approve the Final Locations of the Ponds. See Sheet M6e for Specific Size Requirements for Each Pond. The Ponds Shall be this Size or Larger.

2. The Centerline of the Groundwater Dewatering Trenches T4, T5, T7, T10, T12, T13 Shall Follow the Centerline of the New Stream Channel.

LEGEND

T1 — Groundwater Dewatering Trench

SPA — General Detention Pond Locations

Trench Discharge Pipe

3+00 — Diversion Channel

1+00 — Reconstructed Channel Alignment with Downstream Stationing as Designed by Interfluve, Inc.

Horizontal Extent Of Tailings Impacted Soil. Line Provided In Electronic Format By ARCO And Modified By Maxim Technologies Based On Field Verification Completed In November 1997

N

0 100 200
Feet

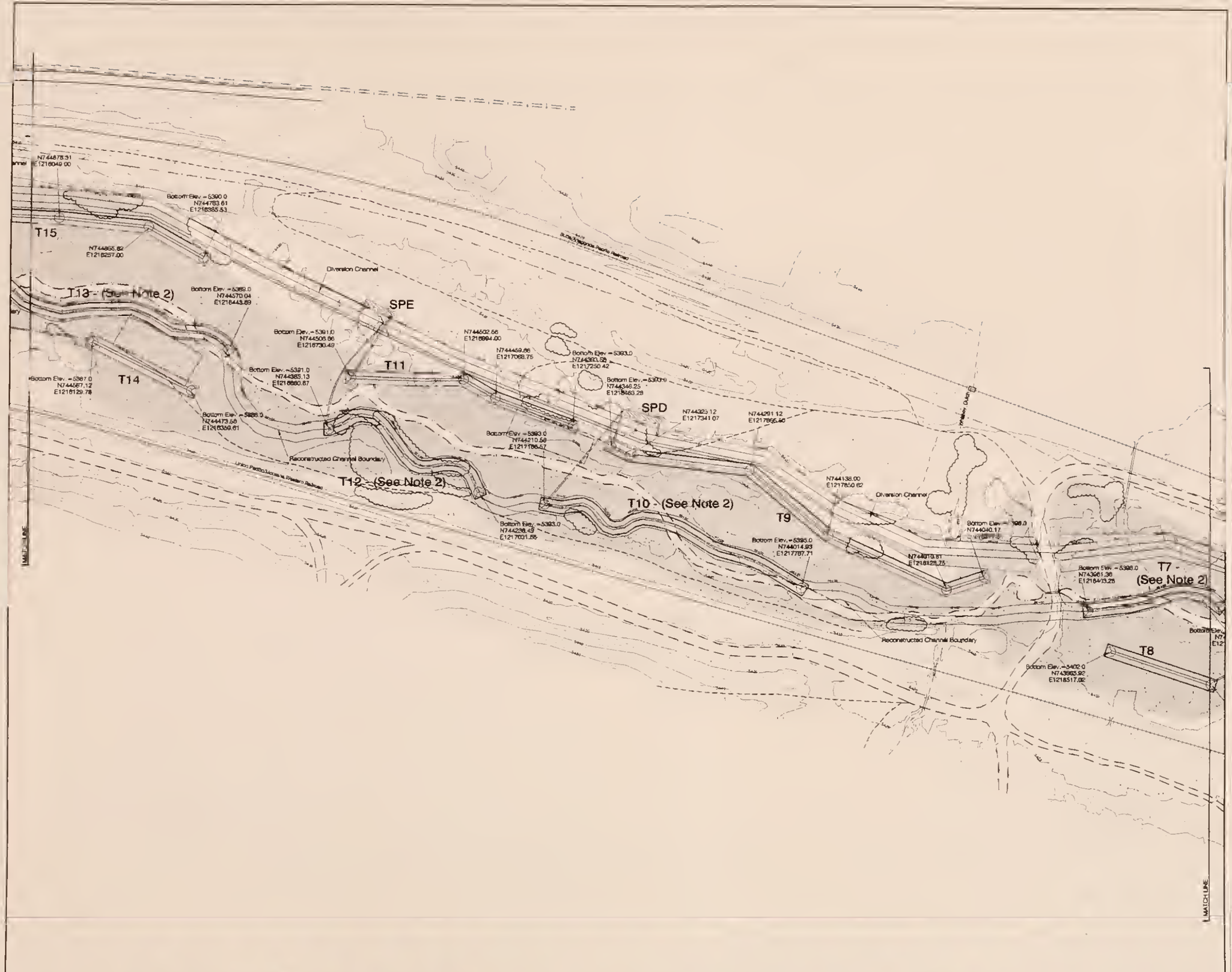
REV	DATE	DESCRIPTION	DRN BY	APP BY

Date: June 18, 1999
Project # 9853483.700

Final Design
Streamside Tailings Operable Unit
Silver Bow Creek - Subarea I - Reach A

Groundwater Dewatering Plan
SHEET M6b

MAXIM TECHNOLOGIES INC



NOTES

1. Sediment Detention Pond Locations Shown on this Sheet are Approximate. The Engineer Shall Approve the Final Locations of the Ponds. See Sheet M6e for Specific Size Requirements for Each Pond. The Ponds Shall be this Size or Larger.

2. The Centerline of the Groundwater Dewatering Trenches T4, T5, T7, T10, T12, T13 Shall Follow the Centerline of the New Stream Channel.

LEGEND

T1 — Groundwater Dewatering Trench

SPA — General Detention Pond Locations

Trench Discharge Pipe

3:1 OD — Diversion Channel

1:1 OD — Reconstructed Channel Alignment with Downstream Stationing as Designed by Interfluve, Inc.

Horizontal Extent Of Tailings Impacted Soil. Line Provided In Electronic Format By ARCO And Modified By Maxim Technologies Based On Field Verification Completed In November 1997

N

0 100 200
Feet

REV	DATE	DESCRIPTION	DRN BY	APP BY

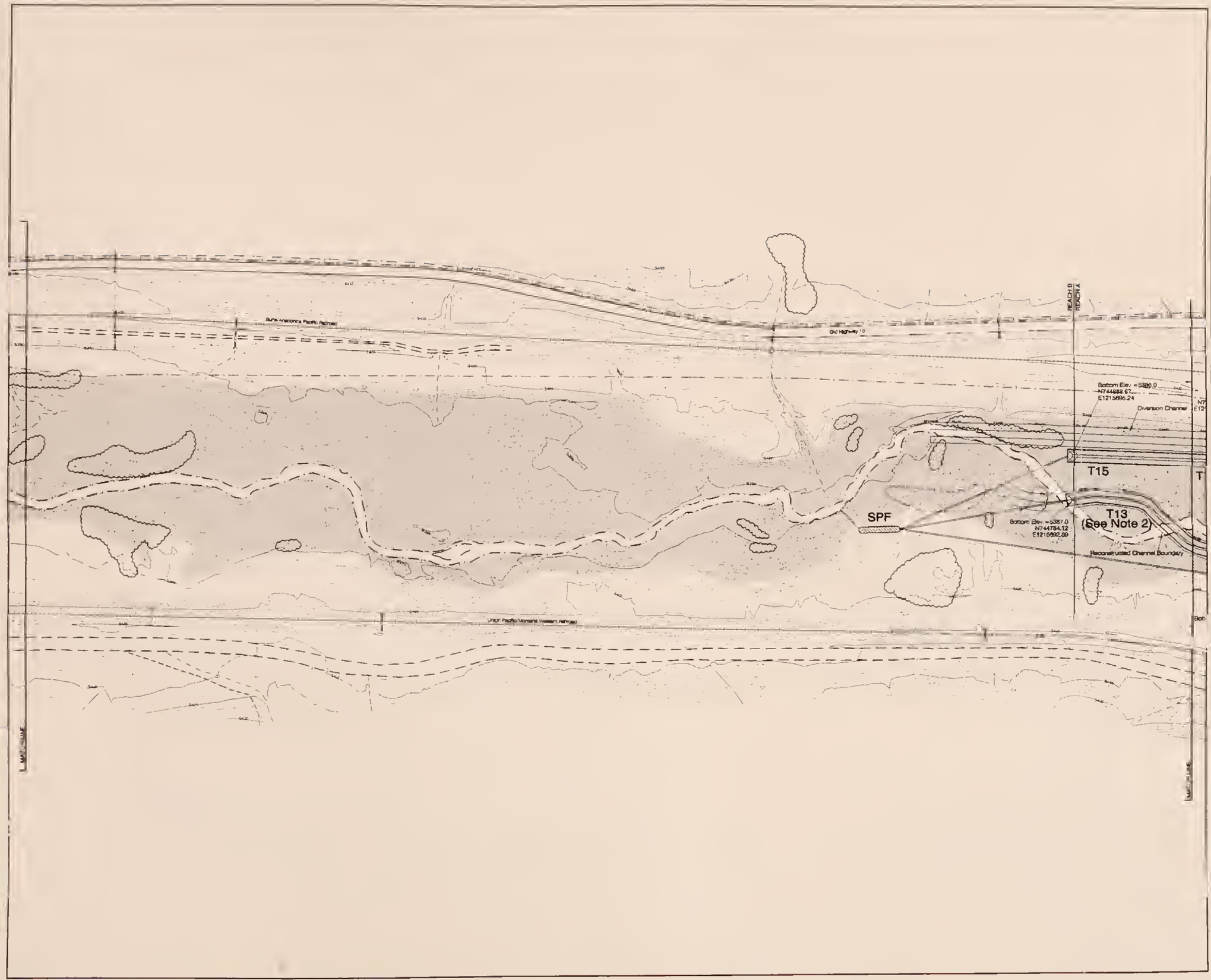
Date: June 18, 1999

Project # 8663-493.700

Final Design
Streamside Tailings Operable Unit
Silver Bow Creek - Subarea I - Reach A

MAXIM TECHNOLOGIES INC

Groundwater Dewatering Plan
SHEET M6c



NOTES

1. Sediment Detention Pond Locations Shown on this Sheet are Approximate. The Engineer Shall Approve the Final Locations of the Ponds. See Sheet M6e for Specific Size Requirements for Each Pond. The Ponds Shall be this Size or Larger.

2. The Centerline of the Groundwater Dewatering Trenches T4, T5, T7, T10, T12, T13 Shall Follow the Centerline of the New Stream Channel

LEGEND

T1 — Groundwater Dewatering Trench

SPA — General Detention Pond Locations

Trench Discharge Pipe

5+00 — Diversion Channel

1+00 — Reconstructed Channel Alignment with Downstream Stationing as Designed by Interfluve, Inc.

Horizontal Extent Of Tailings Impacted Soil. Line Provided In Electronic Format By ARCO And Modified By Maxim Technologies Based On Field Verification Completed In November 1997

N

0 100 200
Feet

REV	DATE	DESCRIPTION	DRN. BY	APP. BY

Date: June 18, 1999

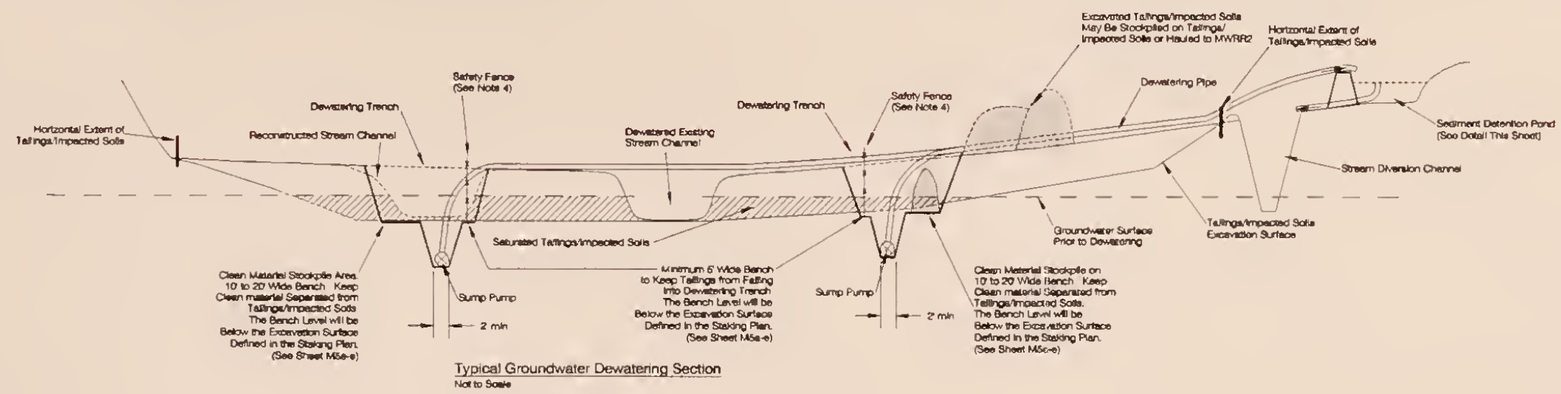
Project # 8653483.700

File G:\projects\act-eng\ref-plan\sbb-mtr.dwg

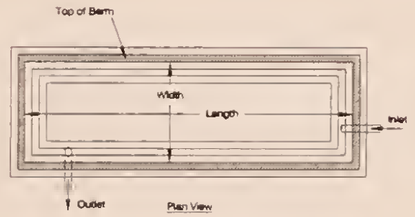
MAXIM TECHNOLOGIES INC

Final Design
Streamside Tailings Operable Unit
Silver Bow Creek - Subarea I - Reach A

Groundwater Dewatering Plan
SHEET M6d

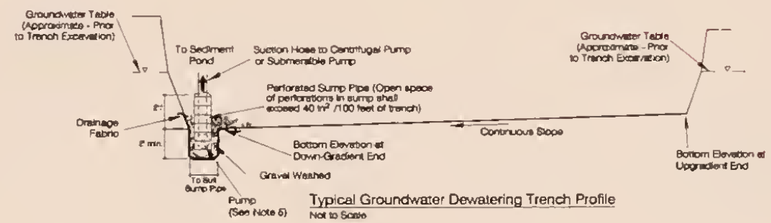

Excavated Tailings/Impacted Soils May Be Stockpiled on Tailings/ Impacted Soils or Hauled to MWRF
Horizontal Extent of Tailings/Impacted Soils
Dewatering Pipe
Safety Fence (See Note 4)
Dewatering Trench
Safety Fence (See Note 4)
Horizontal Extent of Tailings/Impacted Soils
Reconstructed Stream Channel
Dewatered Existing Stream Channel
Dewatering Trench
Sediment Detention Pond (See Detail This Sheet)
Stream Diversion Channel
Saturated Tailings/Impacted Soils
Groundwater Surface Prior to Dewatering
Tailings/Impacted Soils Excavation Surface
Clean Material Stockpile Area. 10 to 20' Wide Bench. Keep Clean material Separated from Tailings/Impacted Soils. The Bench Level will be Below the Excavation Surface Defined in the Staking Plan. (See Sheet M5e-e)
Sump Pump
2' min
Minimum 6' Wide Bench to Keep Tailings from Falling Into Dewatering Trench. The Bench Level will be Below the Excavation Surface Defined in the Staking Plan. (See Sheet M5a-e)
Sump Pump
2' min
Clean Material Stockpile on 10' to 20' Wide Bench. Keep Clean material Separated from Tailings/Impacted Soils. The Bench Level will be Below the Excavation Surface Defined in the Staking Plan. (See Sheet M5c-e)

Typical Groundwater Dewatering Section
Not to Scale

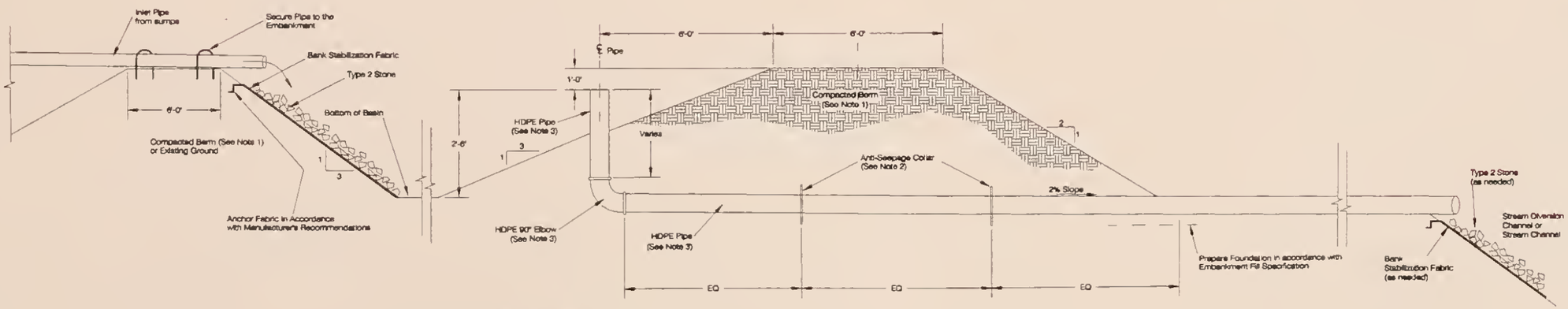


Sediment Pond	Length (feet)	Width (feet)
SPA	66	16
SPB	86	16
SPC	96	21
SPD	102	22
SPE	76	16
SPF	96	21

Sediment Detention Pond Sizes
Not to Scale


Groundwater Table (Approximate - Prior to Trench Excavation)
To Sediment Pond
Suction Hose to Centrifugal Pump or Submersible Pump
Perforated Sump Pipe (Open space of perforations in sump shall exceed 40 in² /100 feet of trench)
Drainage Fabric
2' min
Continuous Slope
Bottom Elevation at Down-Gradient End
Gravel Washed
To Bot Sump Pipe
Pump (See Note 5)
Groundwater Table (Approximate - Prior to Trench Excavation)
Bottom Elevation at Upgradient End

Typical Groundwater Dewatering Trench Profile
Not to Scale



Typical Sediment Detention Pond Section
Not to Scale

NOTES

1. The fill for the berm shall be on-site materials. Source of fill shall be from the basin excavation. Fill shall be placed as a structure embankment and compacted to 95% of maximum dry density. Fill shall have no rocks larger than 6" diameter. Each compacted lift shall be scarified to a depth of at least 2 inches prior to the placement of the next lift.

2. Anti-seepage collars shall be 2'x2' and compatible with smooth or corrugated wall pipe. The collars shall be Anti-seep collar by Agri Drain (Adair, Iowa; 1-800-232-4742) or equal.

3. Outlet pipe shall be HDPE, smooth interior corrugated, Advanced Drainage Systems, Inc. Type N-12 or equal. Pipe and fittings shall be 12" diameter.

4. The safety fence shall be 48" high plastic orange "snow" fence.

5. The pumps shall have a minimum capacity of 50gpm per 100 feet of trench.

6. When the trench discharge is rerouted from the sediment detention pond to the stream diversion channel or stream channel, the channel banks need to be protected for erosion at the new discharge points in a similar manner as the sediment basin discharge.

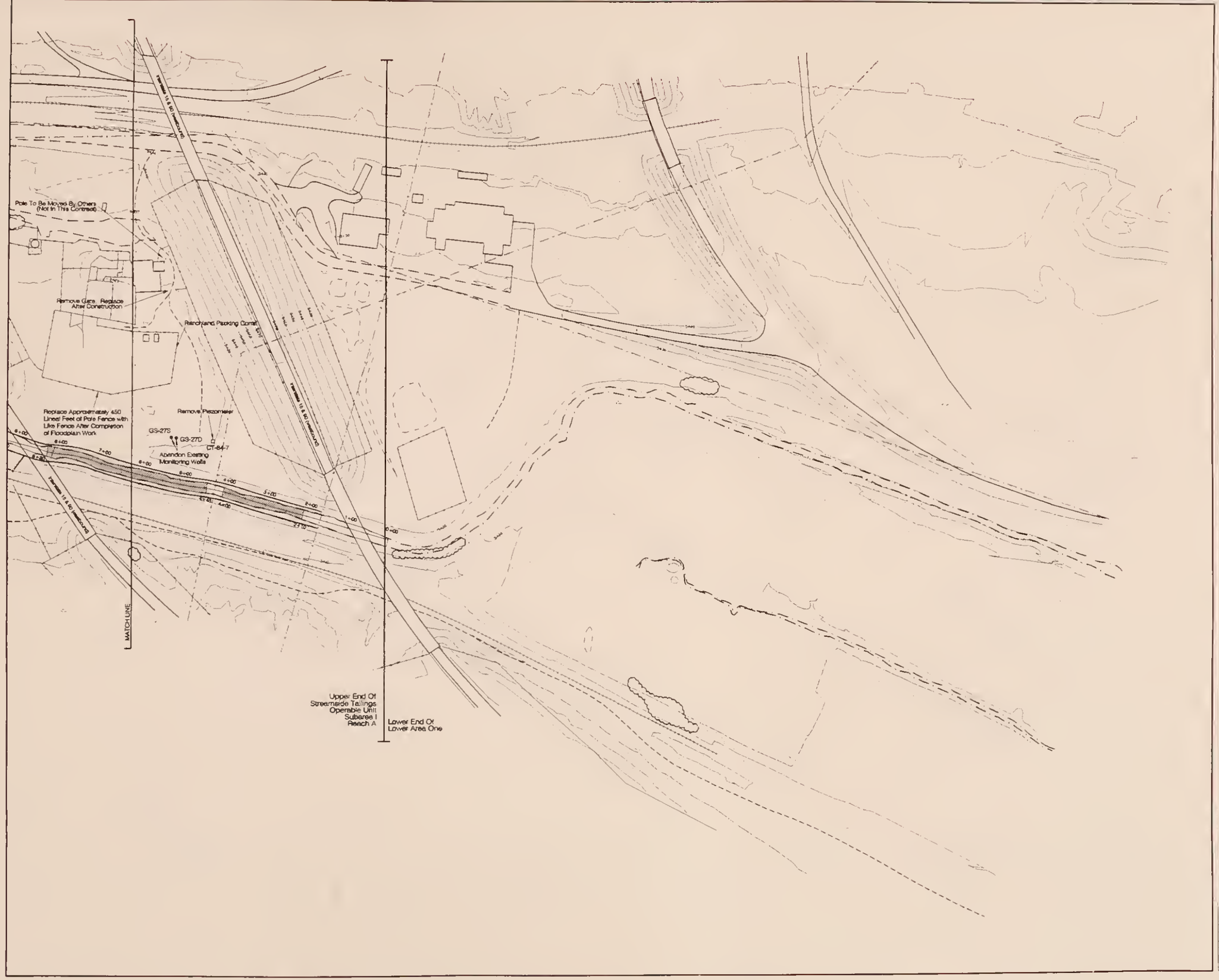
REV	DATE	DESCRIPTION	DRN BY	APP BY

Date: June 14, 1999
Project #: 6555-003.700
File: g:\projects\arch\dwg\final-design\dewater\dewater13.dwg

Project Title: Final Design
Streamside Tailings Operable Unit
Silver Bow Creek - Subarea I - Reach A

MAXIM TECHNOLOGIES INC

Drawn Title: Groundwater Dewatering Details
SHEET M6e



LEGEND

- Existing Silver Bow Creek
- Reconstructed Channel Alignment With Downstream Stationing As Designed by Inbarfluve, Inc.
- Approximate Areas of In-Stream Sediment Removal In Non-flowing Conditions Haul to Milne Waste Relocation Repository 2 (MWRR2)
- Approximate Areas of In-Stream Sediment Removal Behind Cofer Dams In Flowing Conditions Haul to Milne Waste Relocation Repository 2 (MWRR2)
- New Fence Installed For Remedy

N

0 100 200
Feet

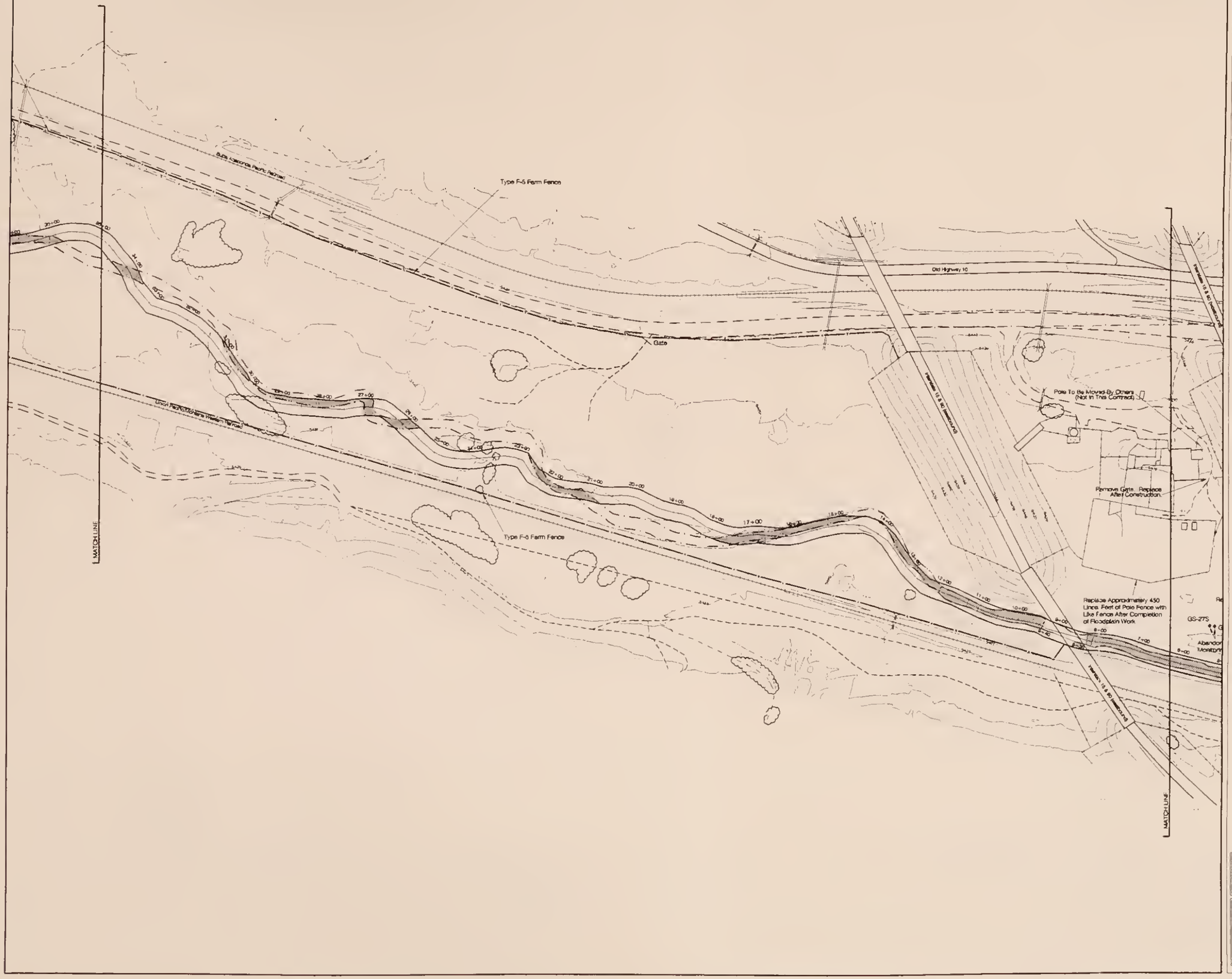
REV	DATE	DESCRIPTION	DRN BY	APP'D

Date: June 15, 1999
Project #: 6883-003.100
File: g:\projects\final\design\streamsed.dwg

MAXIM TECHNOLOGIES INC

Project Title:
Final Design
Streamside Tailings Operable Unit
Silver Bow Creek - Subarea I - Reach A

Sheet Title:
In-stream Sediment Removal,
Fencing, and Well Abandonment Plan
SHEET M7a


Type F-5 Farm Fence
Gate
Old Highway 10
Pole To Be Moved By Others (Not In This Contract)
Remove Grtn. Replace After Construction
Type F-5 Farm Fence
Replace Approximately 450 Linear Feet of Pole Fence with Like Fence After Completion of Floodplain Work
GS-27S
MATCH LINE
MATCH LINE

LEGEND

- Existing Silver Bow Creek
- Reconstructed Channel Alignment With Downstream Stationing As Designed by Interfluve, Inc.
- Approximate Areas of In-Stream Sediment Removal In Non-flowing Conditions Haul to Mine Waste Relocation Repository 2 (MWRR2)
- Approximate Areas of In-Stream Sediment Removal Behind Coffer Dams In Flowing Conditions Haul to Mine Waste Relocation Repository 2 (MWRR2)
- New Fence Installed For Remedy

N

0 100 200 Feet

REV	DATE	DESCRIPTION	DRN BY	APP BY

Date: June 18, 1999

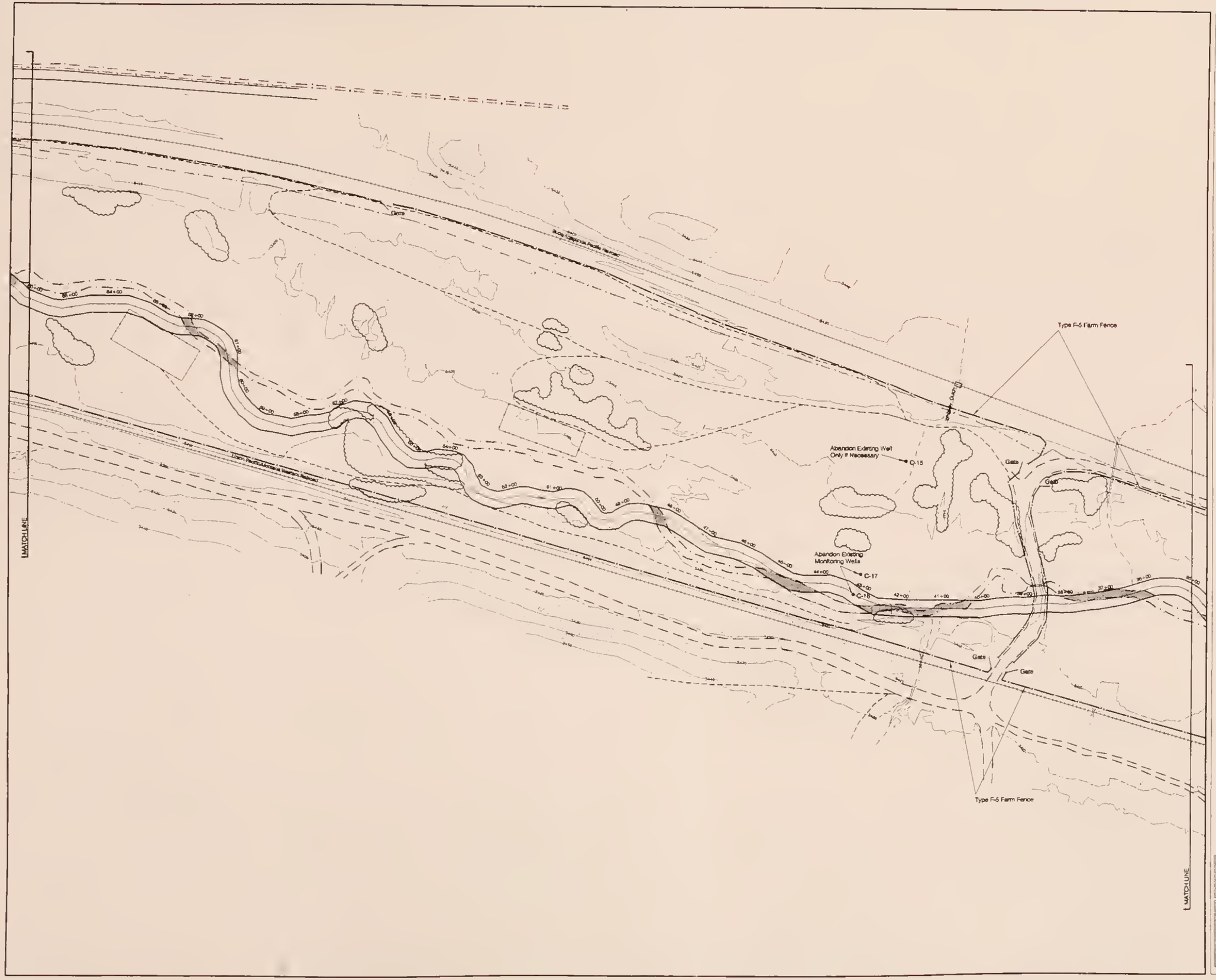
Project #: 98849.700

File: S:\Projects\Final Design\Final Design.dwg

MAXIM TECHNOLOGIES INC

Project Title: Final Design
Streamside Tailings Operable Unit
Silver Bow Creek - Subarea I - Reach A

Sheet Title: In-stream Sediment Removal, Fencing, and Well Abandonment Plan
SHEET M7b



LEGEND

- Existing Silver Bow Creek
- Reconstructed Channel Alignment With Downstream Stationing As Designed by Interfluve, Inc.
- Approximate Areas of In-Stream Sediment Removal In Non-flowing Conditions Haul to Mine Waste Relocation Repository 2 (MWRR2)
- Approximate Areas of In-Stream Sediment Removal Behind Coffer Dams In Flowing Conditions Haul to Mine Waste Relocation Repository 2 (MWRR2)
- New Fence Installed For Remedy

N

0 100 300
Feet

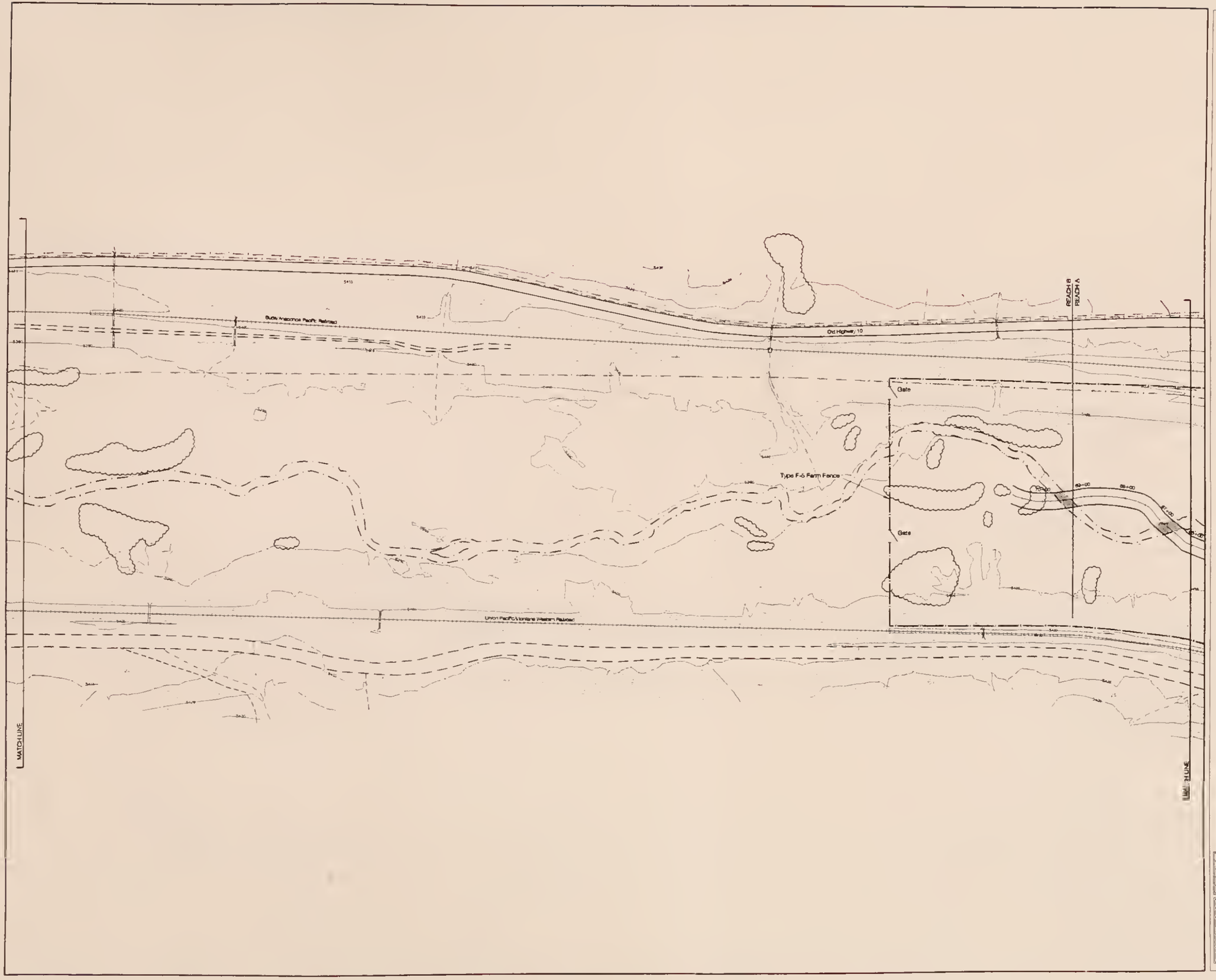
REV	DATE	DESCRIPTION	DRN BY	APP BY

Date: June 15, 1999
Project #: 2825-480.700
File: G:\Projects\silverbow\final\fnl-m7c.dwg

MAXIM TECHNOLOGIES INC

Project Title: Final Design
Streamside Tailings Operable Unit
Silver Bow Creek - Subarea I - Reach A

Sheet Title: In-stream Sediment Removal, Fencing, and Well Abandonment Plan
SHEET M7c



LEGEND

- Existing Silver Bow Creek
- Reconstructed Channel Alignment With Downstream Stationing As Designed by Interfluve, Inc.
- Approximate Areas of In-Stream Sediment Removal In Non-flowing Conditions Haul to Mine Waste Relocation Repository 2 (MWRR2)
- Approximate Areas of In-Stream Sediment Removal Behind Coffer Dams In Flowing Conditions Haul to Mine Waste Relocation Repository 2 (MWRR2)
- New Fence Installed For Remedy

N

0 100 200
Feet

REV	DATE	DESCRIPTION	DRN BY	APP BY

Date: June 18, 2009

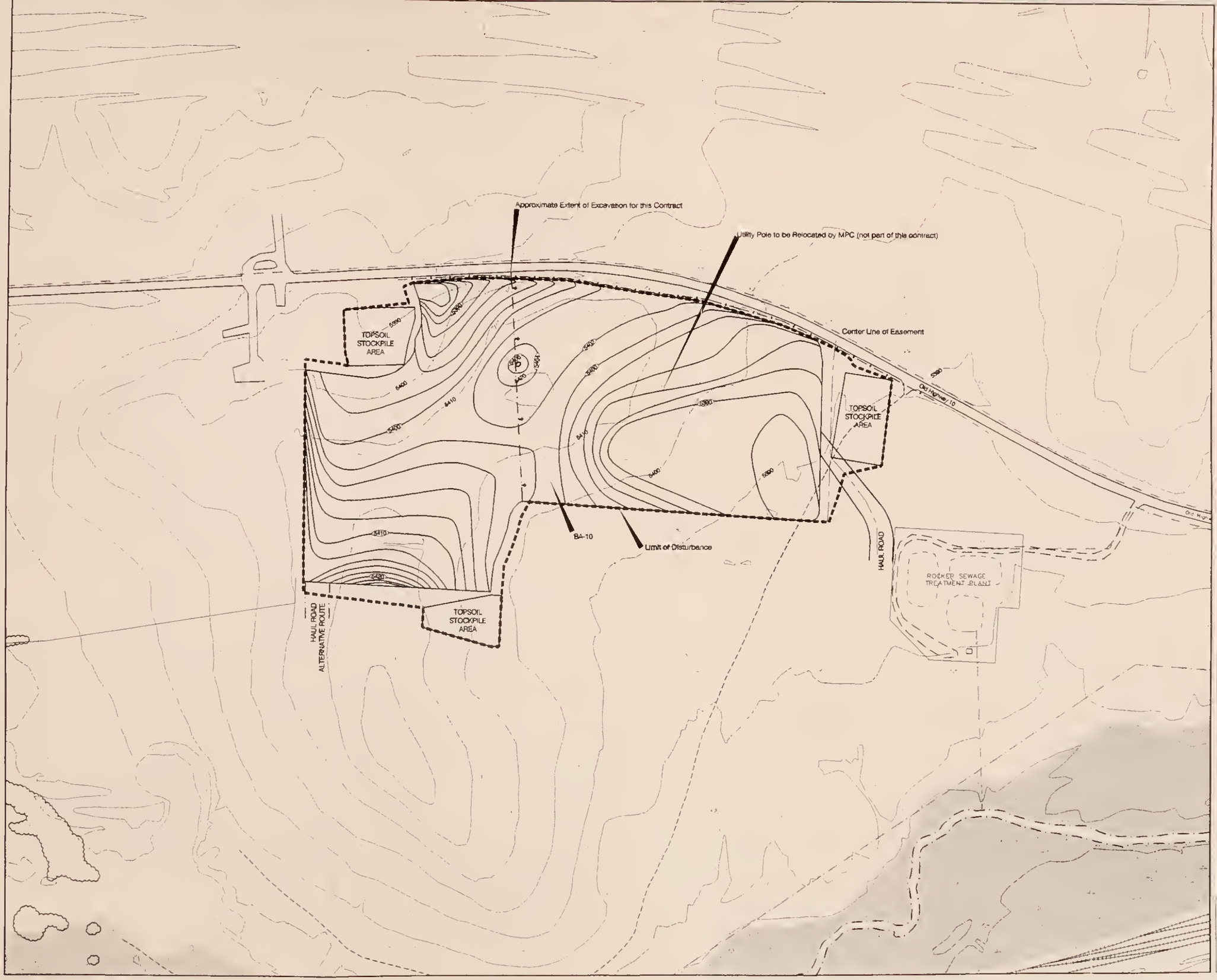
Project #: 9825-003.700

File: g:\projects\silver_bow_creek\maps\figures\sbc_fig_m7d.dwg

MAXIM TECHNOLOGIES INC

Project Title:
Final Design
Streamside Tailings Operable Unit
Silver Bow Creek - Subarea I - Reach A

Sheet Title:
In-stream Sediment Removal, Fencing, and Well Abandonment Plan
SHEET M7d



NOTES

1. No reclaimed slopes shall be steeper than 4 to 1 H:V. Temporary slopes can be 2 to 1 H:V.
2. Reestablish drainages during reclamation.
3. The top 6" of soil shall be stockpiled for reclamation of the borrow area.
4. All excavation shall be to the final excavation contours.
5. Stream and Base topography provided by Hortzon Inc., 1991. Two foot contour interval presented in feet above mean sea level (MSL). Other base features provided by Hortzon Inc., 1989/1991.

LEGEND

- 5410 — Excavated Borrow Area Contours
- Boundary Of Borrow Area
- Limit of Disturbance

Hortizontal Extent Of Tailings Impacted Soil Line Provided In Electronic Format By ARCO And Modified By Maxim Technologies Based On Field Verification Completed In November 1997

N

0 100 200 Feet

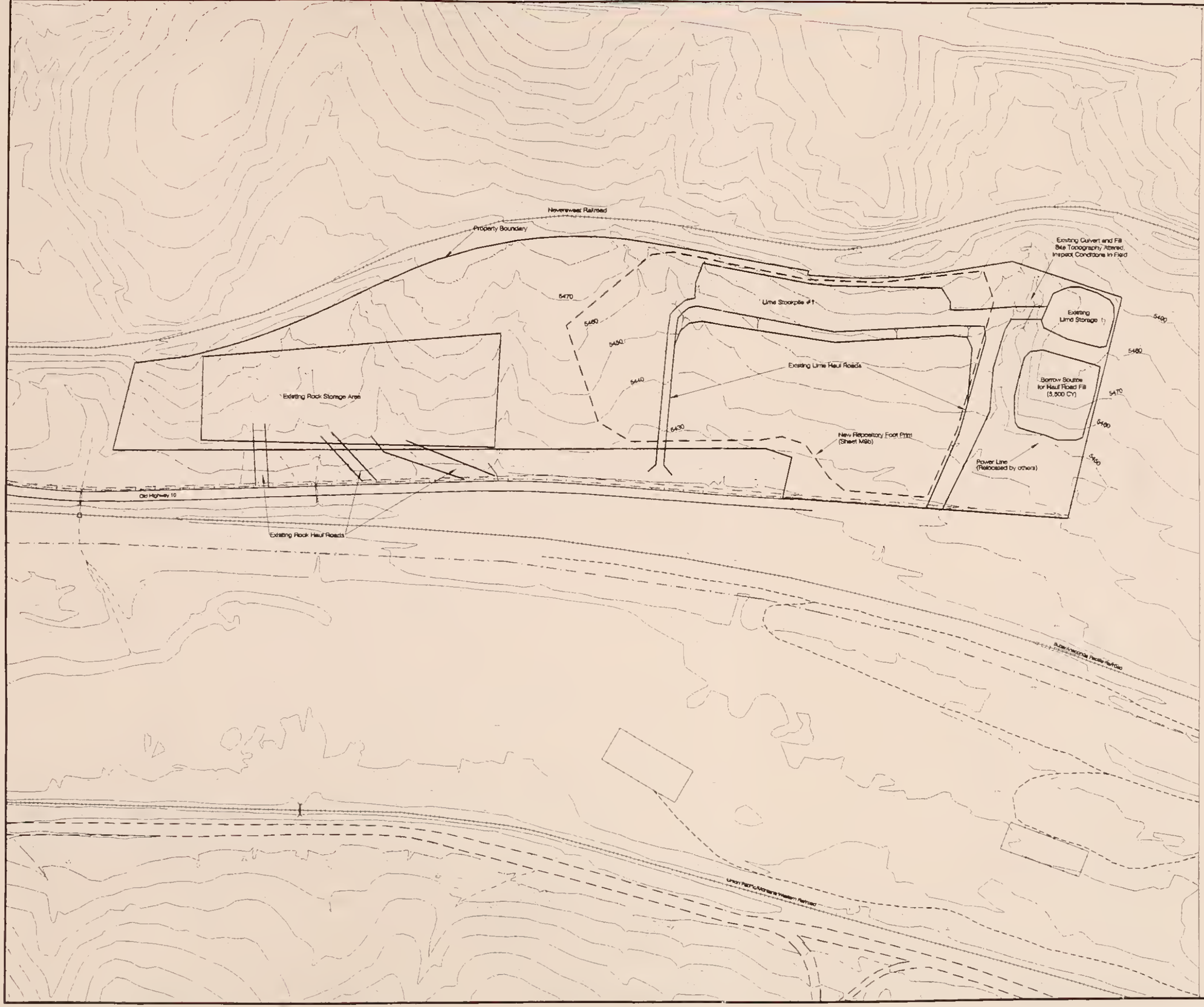
REV	DATE	DESCRIPTION	DRN BY	APP BY

Date: June 16, 1999
Project #: 5860-083.700
File: g:\hydrotech\dwg\mxd\borrow\boarrow10.dwg

Final Design
Streamside Tailings Operable Unit
Silver Bow Creek - Subarea I - Reach A

MAXIM TECHNOLOGIES INC

Borrow Area 10
SHEET M8



Notes:

1. Existing Conditions Shall Be Verified By The Contractor Prior To Start Of Construction. Existing Features Shown Within The Property Boundary Are Approximate.

2. Protect Existing Utilities From Damage. Pay Particular Attention To Fiber Optics Line Located Near Old Highway; See Special Provisions.

3. Strip Topsoil To Depth Of Six Inches Within Disturbance Boundary Limit. Place Topsoil In Stockpile Areas. See Special Provisions.

4. Lime Stockpiles Are Provided To Contractor For Use In Waste Amendment. Contractor Responsible For Maintaining Stockpiles During Construction.

N

0 Feet 200

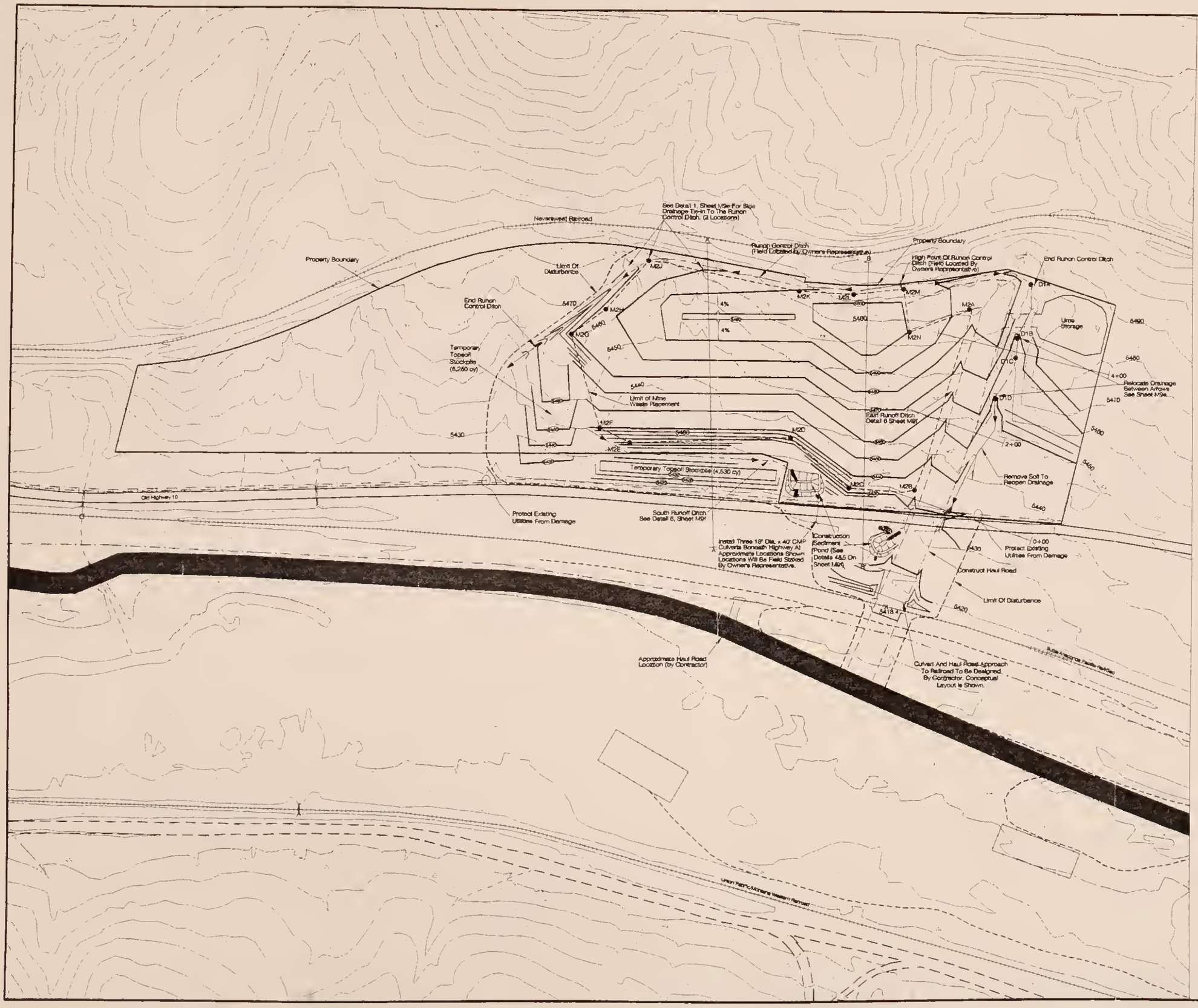
REV	DATE	DESCRIPTION	DRN BY	APP BY

Date: June 18, 1999
Project #: 9953493.110
File: mpbsitemaster\dsgn\ref\repository\sitefeat.dwg

MAXIM TECHNOLOGIES INC

Project Title:
Final Design
Streamside Tailings Operable Unit
Silver Bow Creek - Subarea I

Sheet Title:
Mine Waste Relocation Repository 2
Site Plan - Existing Site Features
SHEET M9a


See Detail 1, Sheet M9e For Ditch Drainage Tie-In To The Runon Control Ditch. (2 Locations)
Nevada-west Railroad
Property Boundary
Limit Of Disturbance
End Runon Control Ditch
Runon Control Ditch (Field Located By Owner's Representative)
High Point Of Runon Control Ditch (Field Located By Owner's Representative)
Property Boundary
End Runon Control Ditch
Temporary Topsoil Stockpile (8,250 cy)
Limit of Mine Waste Placement
East Runoff Ditch Detail 6 Sheet M9f
Lime Drainage
Relocate Drainage Between Arrows See Sheet M9e
Remove Soil To Reopen Drainage
Temporary Topsoil Stockpile (4,530 cy)
Old Highway 10
Protect Existing Utilities From Damage
South Runoff Ditch See Detail 6, Sheet M9f
Construction Sediment Pond (See Details 4&5 On Sheet M9f)
Protect Existing Utilities From Damage
Construct Haul Road
Limit Of Disturbance
Install Three 18' Dia. x 40' CMP Culverts Beneath Highway At Approximate Locations Shown. Locations Will Be Field Staked By Owner's Representative.
Approximate Haul Road Location (by Contractor)
Culvert And Haul Road Approach To Railroad To Be Designed By Contractor. Conceptual Layout Is Shown.
Union Pacific-Montana Western Railroad
N
0
Feet
200

Limit of Mine Waste Placement Coordinates

Reference Point	Northing	Easting
M2A	745833.46	1217033.16
M2B	745211.17	1216907.46
M2C	745214.99	1216754.64
M2D	745331.59	1216617.92
M2E	745316.02	1216243.97
M2F	745351.98	1216173.68
M2G	745569.91	1216106.29
M2H	745628.24	1216165.31
M2J	745742.20	1216284.75
M2K	745873.28	1216635.89
M2L	745866.59	1216762.96
M2M	745680.15	1216679.24
M2N	745579.97	1216693.99

Drainage Coordinates

Reference Point	Northing	Easting
D1A	745693.20	1217177.49
D1B	745586.96	1217143.92
D1C	745521.53	1217143.05
D1D	745426.14	1217096.92

Notes:

1. This Plan Sheet Shows The Repository At Final Buildout Which Includes Placement of Waste From Reach A, Placement Of Topsoil Over The Waste And Construction Of The Runon Control Ditch Along The North Edge Of The Repository. Additional Grading And Reclamation Work Required For The Haul Road Is Shown On Sheet M9c.

2. Protect Existing Utilities From Damage. Pay Particular Attention To Fiber Optics Line Located Near Old Highway 10. See Special Provisions.

3. Volumes Shown For Temporary Topsoil Stockpiles Represent Storage Capacity Available In Each Stockpile. The Actual Amount Of Topsoil Salvaged May Vary Considerably.

4. During Construction, Route Runon Around Areas Containing Mine Wastes. The Repository Surface During Construction Must Be Adequately Graded To Promote Runoff From The Surface.

5. The Repository Shown In The Drawings Is Designed To Store Approximately 198,000 Cubic Yards Which May Be More Than Required For Construction. Line And Grade Adjustments To The Repository And Runon Control Ditch Will Likely Be Necessary To Accommodate The Actual Amount Of Waste Placed.

6. Fill Needed For Constructing The Haul Road At The Repository Will Be Acquired From A Borrow Source Located East Of The Repository (See Sheet M9e). Contractor Will Need To Import Additional Fill Material.

7. Additional Details And Cross-Sections Of The Repository Construction Are Shown On Sheets M9d, M9e and M9f.

8. Haul Road Shown Is For A 65 Foot Road Width. Road Width May Be Varied, Depending On Contractor's Equipment. Alterations To The Haul Road Layout Must Be Approved By Owner's Representative.

9. Install Silt Fence And Other Suitable Erosion Control Measures To Prevent Waste And Cover Soil From Being Transported From The Construction Site.

10. No Permanent Features Shall Be Constructed Outside Of Property Boundary.

11. The Locations Shown For The Lime Storage And Associated Haul Road And Culvert Are Approximate And Are Intended Only To Show Their General Location. The Contractor Is Responsible During Construction To Maintain The Lime Stockpile And Associated Structures As Necessary To Complete Construction. This May Include Modifying The Haul Road Layout To The Lime Stockpile And Replacing The Culvert.

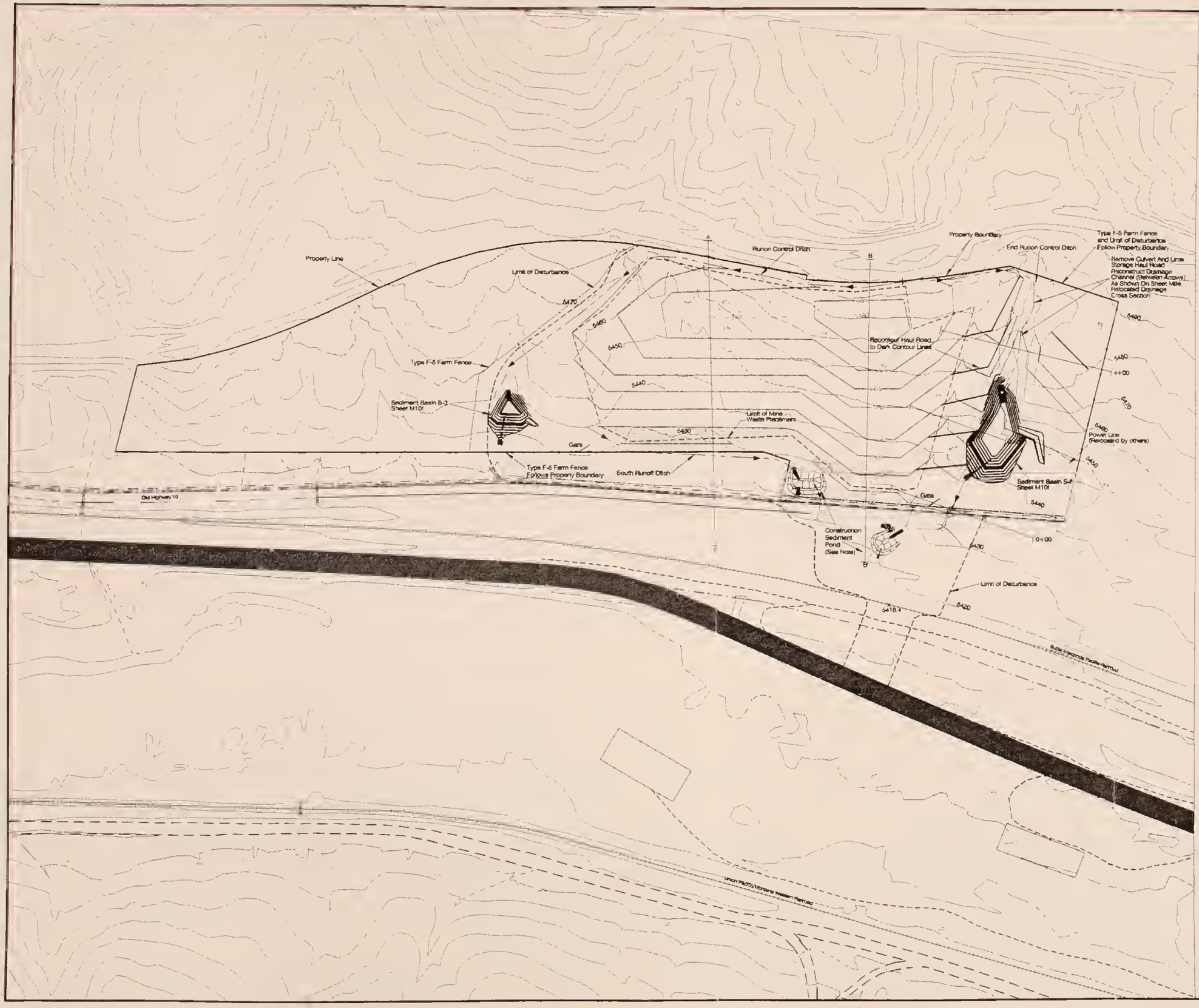
REV	DATE	DESCRIPTION	DRN BY	APP BY

Date: June 16, 1999
Project #: 9853493.110
File: mpdata\eet.engineer\repository\9bfinal.dwg

MAXIM TECHNOLOGIES INC

Project Title: Final Design
Streamside Tailings Operable Unit
Silver Bow Creek - Butte Area

Sheet Title: Mine Waste Relocation Repository 2
Site Plan - Final Buildout
SHEET M9b



Notes:

1. This Plan Sheet Shows The Final Reclamation Contours And Features Following Reclamation.

2. Construction Sediment Ponds Shall Remain In Place After Completion Of MWRR2 Contract. The East Runoff Ditch Shall Be Removed And Recontoured As Shown.

3. Reclaim Lime Storage Area.

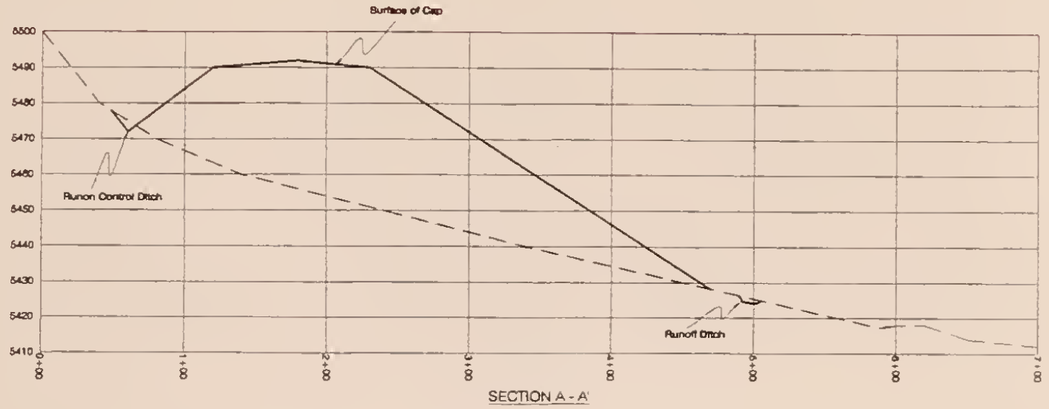
REV	DATE	DESCRIPTION	DRN BY	APP BY

Date: June 18, 1998
Project #: 9953483.110
File: npsilesecandagreat\mpowerlpsitrec.dwg

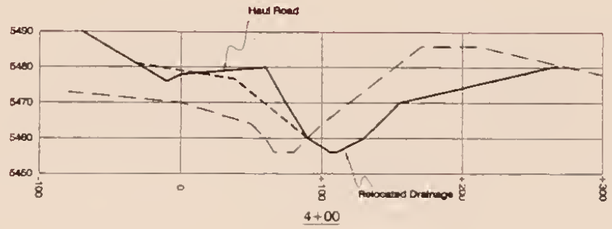
Project Title: Final Design
Streamside Tailings Operable Unit
Silver Bow Creek - Subarea I

Sheet Title: Mine Waste Relocation Repository 2
Site Plan - Reclamation
SHEET M9c

MAXIM TECHNOLOGIES INC

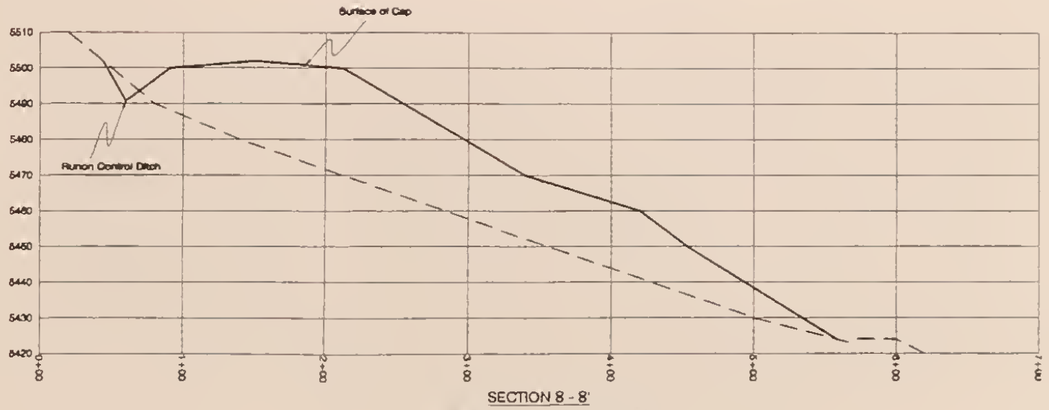


SECTION A - A'



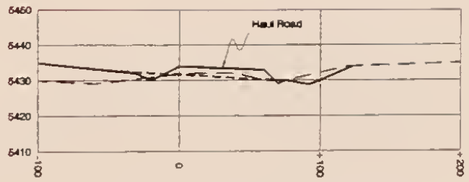
4+00

2+00



SECTION 8 - 8'

MWRR SECTIONS - LOOKING EAST



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HAUL ROAD SECTIONS - LOOKING NORTH

LEGEND

- Existing Ground
- Grade at Final Buildout
- Grade after Reclamation

REV	DATE	DESCRIPTION	DRN BY	APP BY

Date: June 18, 1999

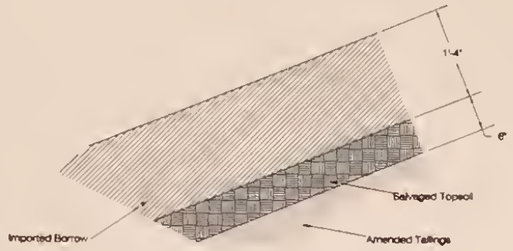
Project #: 68272991.110

File: g:\cyc\dataset\diagnost.mpcad\y\mwr3sn1.dwg

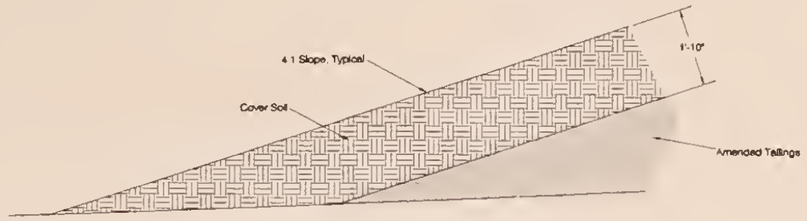
MAXIM TECHNOLOGIES INC

Proj per Title: Final Design
Streamside Tailings Operable Unit
Silver Bow Creek - Subarea I

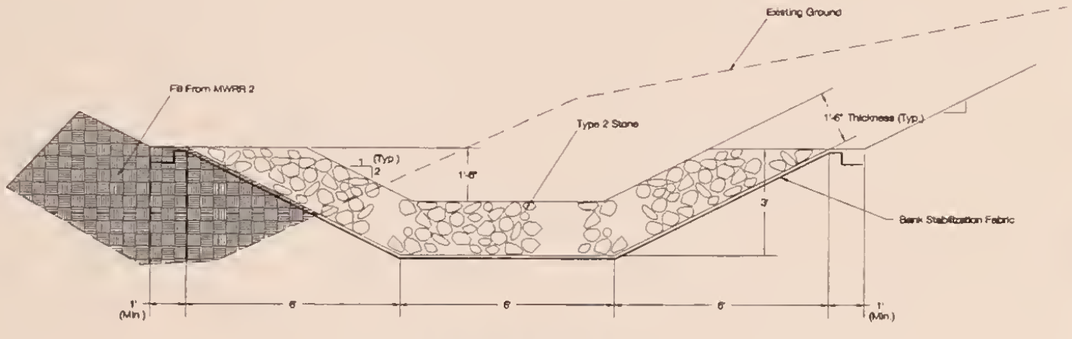
Sheet Title: Mine Waste Relocation Repository 2
Sections
SHEET M9d



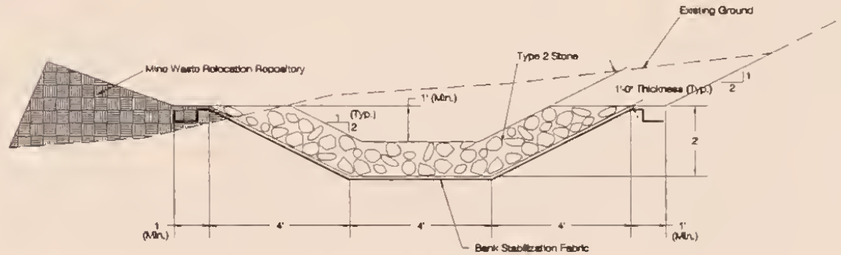
Typical Cover Soil Detail
No Scale



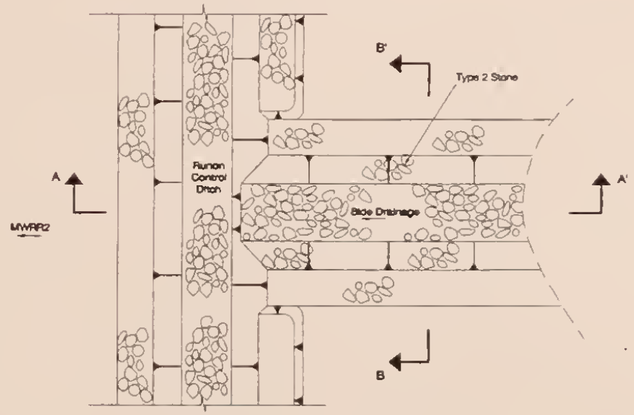
Typical Embankment Toe Detail
No Scale



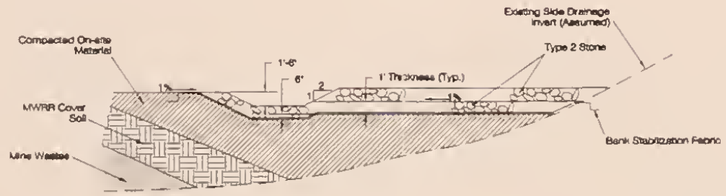
Typical Relocated Drainage Cross-Section
(East of Haul Road)
Scale 1" = 2'



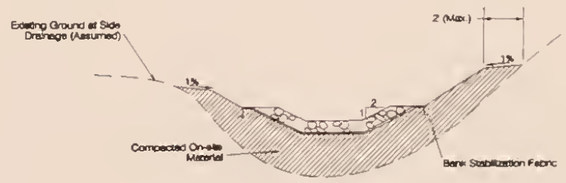
Typical Run-on Ditch Cross-Section
Scale 1" = 2'



Side Drainage Tie-In To Runon Control Ditch
Detail 1
Scale 1" = 6'



Side Drainage Tie-In To Runon Control Ditch
Section A-A'
Scale 1" = 6'



Side Drainage Tie-In To Runon Control Ditch
Section B-B'
Scale 1" = 6'

Notes:
1. Runon Control Ditch Shall Be Field Located by the Owner's Representative Maximum Slope of Runon Control Ditch is 20% (0.2 ft/ft) and Minimum Slope is 1% (0.01 ft/ft)

2. Side Drainage Layout Shall Be Field Staked by the Owner's Representative

REV	DATE	DESCRIPTION	DRN BY	APP BY

Project Title: Final Design
Streamside Tailings Operable Unit
Silver Bow Creek - Subarea I - Reach A

Drawn Title: Mine Waste Relocation Repository 2
Details
SHEET M9e

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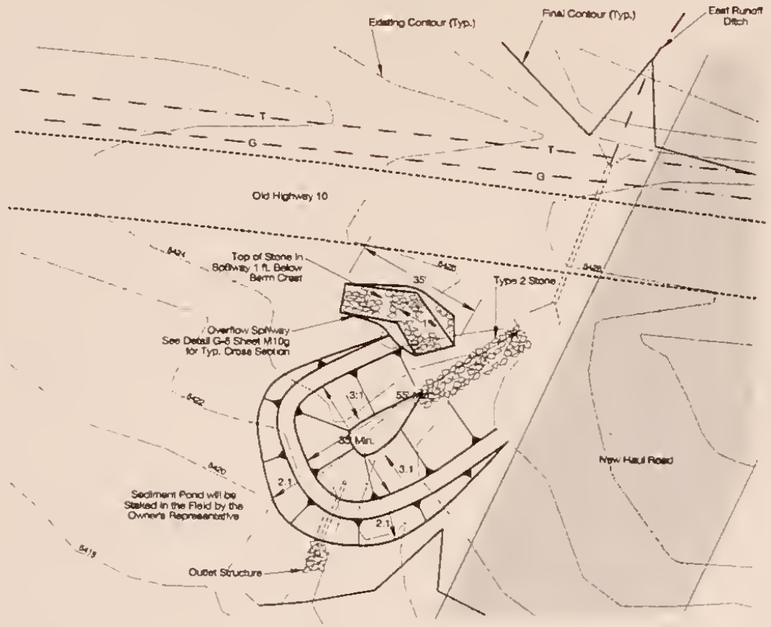
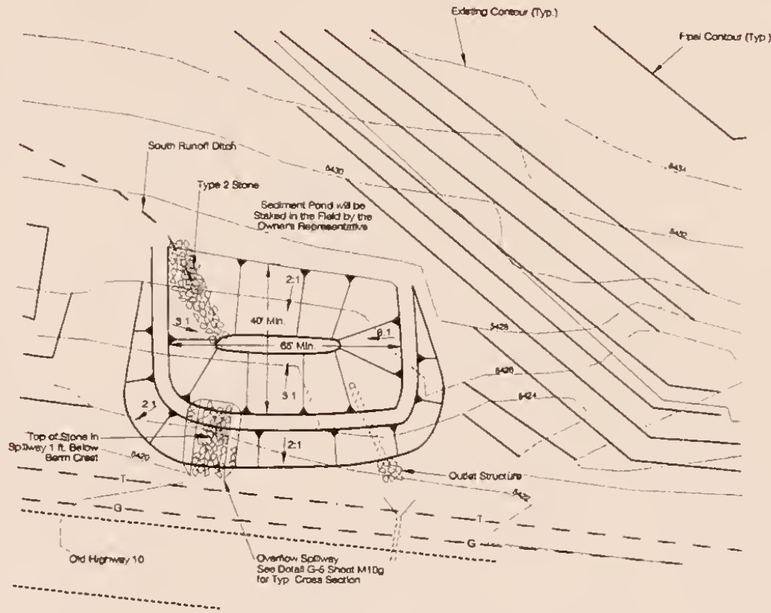
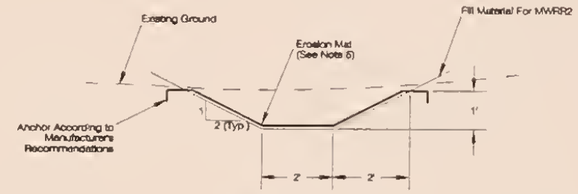

Existing Contour (Typ.)
Final Contour (Typ.)
East Runoff Ditch
Old Highway 10
Top of Stone in Spillway 1 ft. Below Berm Crest
35'
Type 2 Stone
Overflow Spillway See Detail G-6 Sheet M10g for Typ. Cross Section
55' Min.
3:1
2:1
New Haul Road
Sediment Pond will be Staked in the Field by the Owner's Representative
Outlet Structure

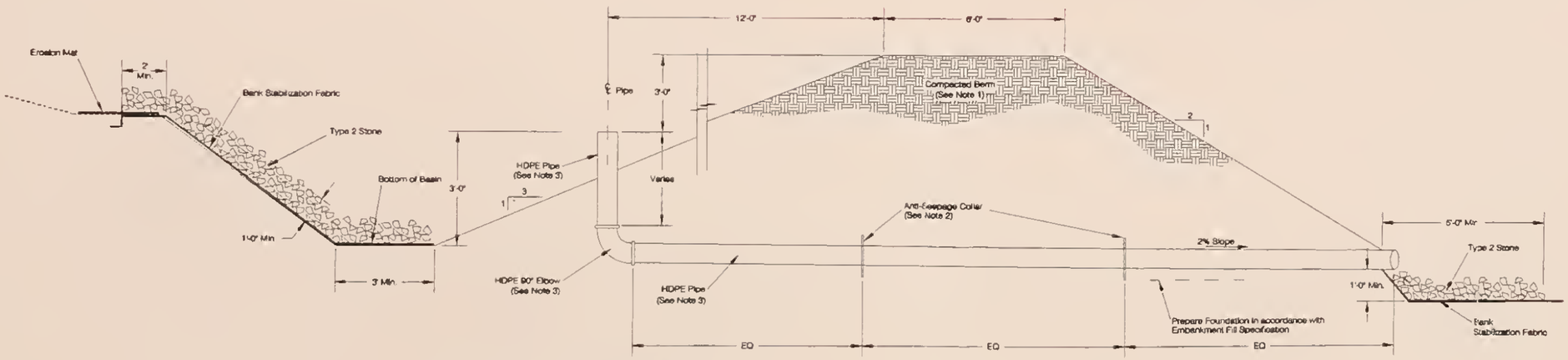
Detail 5
East MWRR2 Construction Sediment Pond
1" = 20'


Existing Contour (Typ.)
Final Contour (Typ.)
South Runoff Ditch
Type 2 Stone
Sediment Pond will be Staked in the Field by the Owner's Representative
2:1
3:1
40' Min.
65' Min.
Top of Stone in Spillway 1 ft. Below Berm Crest
Outlet Structure
Old Highway 10
Overflow Spillway See Detail G-6 Sheet M10g for Typ. Cross Section

Detail 4
West MWRR2 Construction Sediment Pond
1" = 20'



Detail 6
Typical For South and East MWRR2 Runoff Ditches
See Notes 5 and 6
Not to Scale



Typical MWRR2 Construction Sediment Pond Section
Not to Scale

NOTES

1. The fill for the berms shall be on-site materials. Source of fill shall be from the basin excavation and surrounding areas. Fill shall be placed as a structure embankment and compacted to 95% of maximum dry density. Fill shall have no rocks larger than 6" diameter. Each compacted lift shall be scarified to a depth of at least 2 inches prior to the placement of the next lift.

2. Anti-seepage collars shall be 2'x2' and compatible with smooth or corrugated wall pipe. The collars shall be Anti-seep collar by Agri Drain (Adair, Iowa; 1-800-232-4742) or equal.

3. Outlet pipe shall be HDPE, smooth interior corrugated, Advanced Drainage Systems, Inc. Type N-12 or equal. Pipe and fittings shall be 12" diameter.

4. Sediment ponds and runoff ditches shall be field located and staked by the owner's representative.

5. Erosion mat for runoff ditches shall be North American Green type S75 or equal.

6. The east runoff ditch shall be removed and recontoured for reclamation. The erosion mat for the south runoff ditch shall be removed for revegetation and then reinstalled.

NO.	DATE	DESCRIPTION	DRAWN BY	APPR. BY

Date: June 14, 1999
Project #: 98B5-425.700
File: g:\projects\remediation\repository\repos02.dwg

MAXIM TECHNOLOGIES INC

Project Title: Final Design
Streamside Tailings Operable Unit
Silver Bow Creek - Subarea I - Reach A

Sheet Title: Mine Waste Relocation Repository 2
Details
SHEET M6f

B3.2
Detail A - Sheet M10e

B3.3
M10e

B3.1
Detail A - Sheet M10e

MATCH LINE

Upper End Of
Streamside Tailings
Operable Unit
Subarea I
Reach A

Lower End Of
Lower Area One

Notes
1. Material Quantity Estimates for the Remediation of the Contaminated Railroad Materials Areas B1 through B11 and U1 and U2 are on Sheet M10e.

2. Contaminated Railroad Materials were Initially Identified During the Remedial Investigation (ARCO 1995, Revision 2). Verification and Sampling of the Contaminated Areas was Conducted in September and October 1997 by Maxim Technologies, Inc.

CONTROL POINT TABLE

CONTROL POINT	NORTHING	EASTING	ELEVATION (top of pin)
CCH-5140-B	744241.0	1218610.0	5414.39
CCH-5160-B	744114.0	1218272.0	5400.40
CCH-5190-B	744293.0	1217865.0	5400.05
CCH-5200-B	744292.0	1217865.0	5400.99
CCH-5210-C	744305.0	1217412.0	5401.27
CCH-5220-C	744436.0	1217224.0	5404.22
CCH-5230-C	744496.0	1217017.0	5404.07
CCH-5240-C	744560.0	1216795.0	5400.43
CCH-5250-C	744851.0	1216558.0	5407.70
CCH-5270-C	744953.0	1216213.0	5411.05
CCH-5280-B	744978.0	1216013.0	5406.94
CCH-5300-C	745002.0	1215717.0	5407.89
CCH-5310-C	745015.0	1215431.0	5400.11

LEGEND

B1 — Mine Waste Embankment

CC1 — Concentrate Spills

CCH-5558-A — Control Point

SB-S1 — Sediment Basin

N

0 100 200
Feet

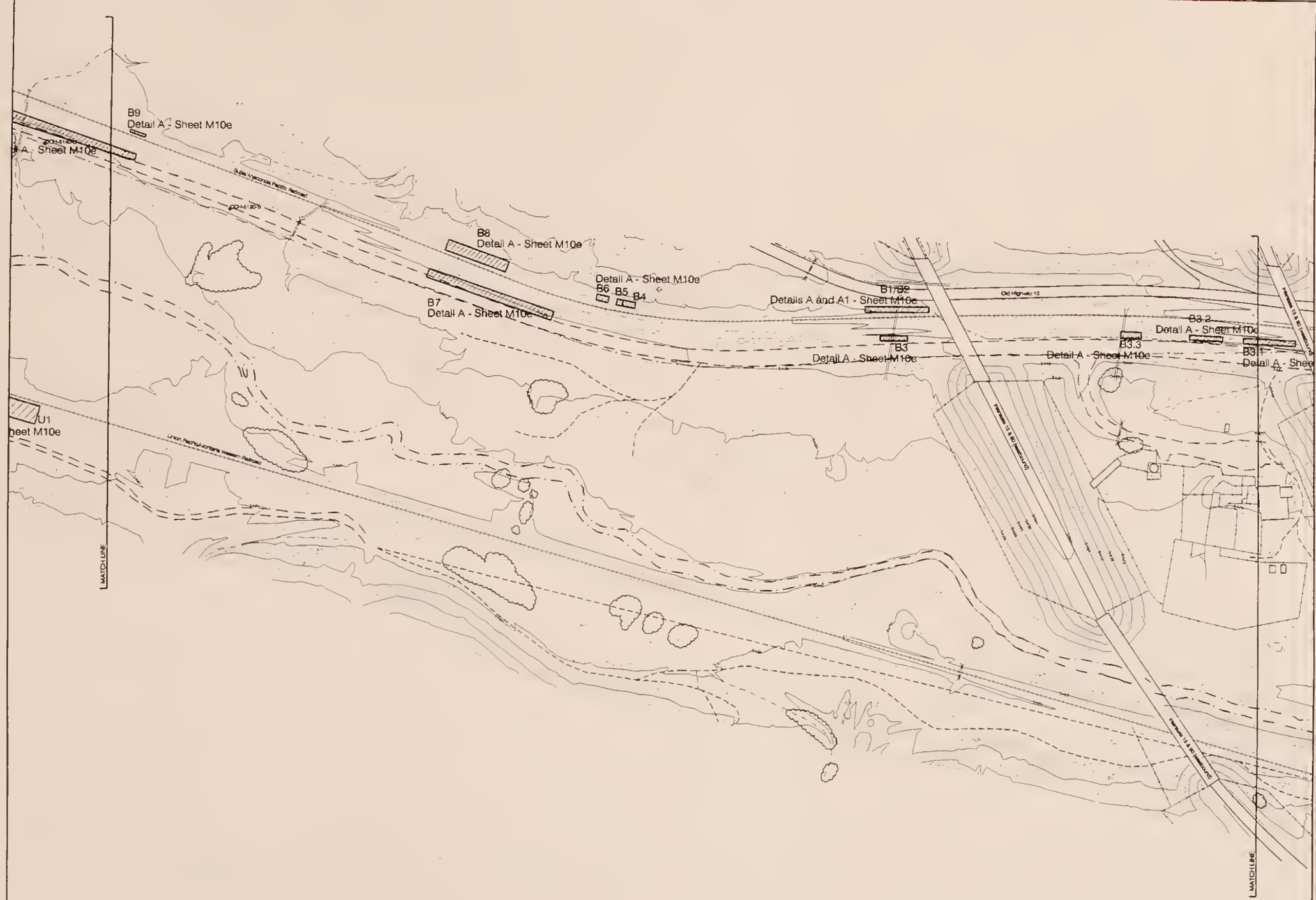
NO.	DATE	DESCRIPTION	DRN BY	APP BY

Date: June 16, 1998
Project #: 998465.700
File: g:\projects\arco\graphics\railmat.dwg

Final Design
Streamside Tailings Operable Unit
Silver Bow Creek - Subarea I - Reach A

RR Materials Remediation
SHEET M10a

MAXIM TECHNOLOGIES INC



Notes

1. Material Quantity Estimates for the Remediation of the Contaminated Railroad Materials Areas B1 through B11 and U1 and U2 are on Sheet M10e.

2. Contaminated Railroad Materials were Initially Identified During the Remedial Investigation (ARCO 1995, Revision 2). Verification and Sampling of the Contaminated Areas was Conducted in September and October 1997 by Maxim Technologies, Inc.

CONTROL POINT TABLE

CONTROL POINT	NORTHING	EASTING	ELEVATION (top of pin)
CCH-5140-B	744241.0	1218910.0	5414.39
CCH-5160-B	744114.0	1218272.0	5408.40
CCH-5190-B	744293.0	1217865.0	5408.05
CCH-5200-B	744292.0	1217665.0	5403.99
CCH-5210-C	744305.0	1217412.0	5401.27
CCH-5220-C	744436.0	1217224.0	5404.22
CCH-5230-C	744495.0	1217017.0	5404.07
CCH-5240-C	744580.0	1216796.0	5400.43
CCH-5260-C	744851.0	1216558.0	5407.70
CCH-5270-C	744953.0	1216213.0	5411.05
CCH-5280-B	744078.0	1216013.0	5408.84
CCH-5300-C	745006.0	1215717.0	5407.89
CCH-5310-C	745015.0	1215431.0	5406.11

LEGEND

- B1 — Mine Waste Embankment
- CC1 — Concentrate Spills
- CCH-5555-A — Control Point
- SB-S1 — Sediment Basin

N

0 100 200
Feet

REV	DATE	DESCRIPTION	DRN BY	APP BY

Date: June 18, 1998
Project #: 998245-700
File: g:\projects\arco\clayton\mxd\mxd\m10e.dwg

Final Design
Streamside Tailings Operable Unit
Silver Bow Creek - Subarea I - Reach A

MAXIM TECHNOLOGIES INC

RR Materials Remediation
SHEET M10b

eet M10f

SB-S2
See Detail - Sheet M10f

B11
Details A and A1 - Sheet M10e

SB-S1
See Detail - Sheet M10f

B10
Detail A - Sheet M10e

U2 U1
Table B - Sheet M10e

MATCH LINE

MATCH LINE

Notes
1. Material Quantity Estimates for the Remediation of the Contaminated Railroad Materials Areas B1 through B11 and U1 and U2 are on Sheet M10e

2. Contaminated Railroad Materials were Initially Identified During the Remedial Investigation (ARCO 1995, Revision 2). Verification and Sampling of the Contaminated Areas was Conducted in September and October 1997 by Maxim Technologies, Inc.

CONTROL POINT TABLE

CONTROL POINT	NORTHING	EASTING	ELEVATION (top of pin)
CCH-5140-B	744241.0	1218610.0	5414.39
CCH-5180-B	744114.0	1218272.0	5409.40
CCH-5190-B	744293.0	1217865.0	5408.05
CCH-5200-B	744292.0	1217865.0	5403.99
CCH-5210-C	744305.0	1217412.0	5401.27
CCH-5220-C	744436.0	1217224.0	5404.22
CCH-5230-C	744495.0	1217017.0	5404.07
CCH-5240-C	744560.0	1216795.0	5403.43
CCH-5260-C	744651.0	1216558.0	5407.70
CCH-5270-C	744953.0	1216213.0	5411.05
CCH-5280-B	744978.0	1216013.0	5408.94
CCH-5300-C	745002.0	1216717.0	5407.99
CCH-5310-C	745015.0	1215431.0	5408.11

LEGEND

B1 Mine Waste Embankment

CC1 Concentrate Spills

CCH-5555-A Control Point

SB-S1 Sediment Basin

N

0 100 200
Feet

REV	DATE	DESCRIPTION	DRN BY	APP BY

Date: June 18, 1999

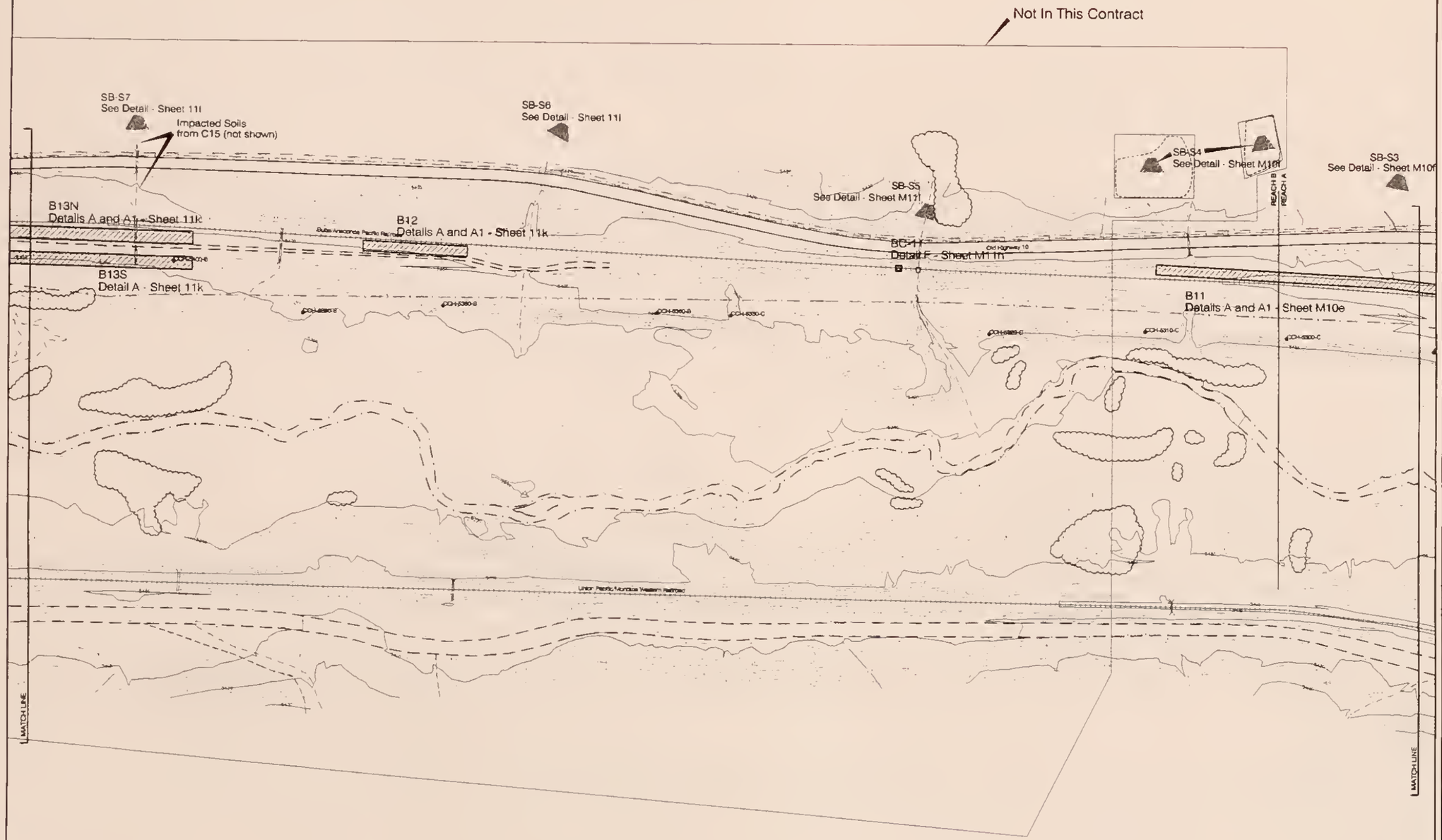
Project # 65404-420

File: g:\cp\billings\silver\dwg\remed\rrmate.dwg

Project Title:
Final Design
Streamside Tailings Operable Unit
Silver Bow Creek - Subarea I - Reach A

MAXIM TECHNOLOGIES INC

Sheet Title:
RR Materials Remediation
SHEET M10c



Notes

1. Material Quantity Estimates for the Remediation of the Contaminated Railroad Materials Areas B1 through B11 and U1 and U2 are on Sheet M10e

2. Contaminated Railroad Materials were initially identified During the Remedial Investigation (ARCO 1995, Revision 2). Verification and Sampling of the Contaminated Areas was Conducted in September and October 1997 by Maxim Technologies, Inc.

CONTROL POINT TABLE

CONTROL POINT	NORTHING	EASTING	ELEVATION (top of pin)
CCH-5140-B	744241.0	1218610.0	5414.39
CCH-5180-B	744114.0	1218272.0	5409.40
CCH-5190-B	744293.0	1217885.0	5408.05
CCH-5200-B	744292.0	1217665.0	5403.99
CCH-5210-C	744305.0	1217412.0	5401.27
CCH-5220-C	744436.0	1217224.0	5404.22
CCH-5230-C	744495.0	1217017.0	5404.07
CCH-5240-C	744580.0	1216795.0	5400.43
CCH-5260-C	744851.0	1216558.0	5407.70
CCH-5270-C	744953.0	1216213.0	5411.05
CCH-5280-B	744976.0	1216013.0	5408.94
CCH-5300-C	745002.0	1215717.0	5407.99
CCH-5310-C	745015.0	1215431.0	5408.11

LEGEND

- B1 — Mine Waste Embankment
- CC1 — Concentrate Spills
- CCH-5555-A — Control Point
- SB-S1 — Sediment Basin

N

0 100 200
Feet

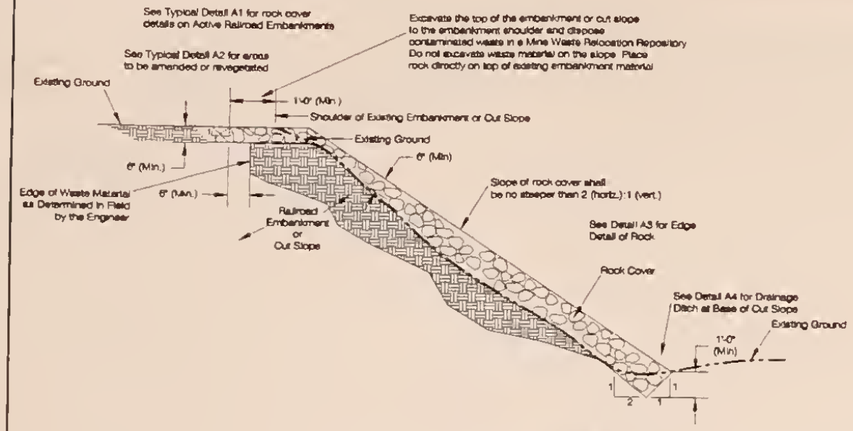
REV	DATE	DESCRIPTION	DRN BY	APP BY

Date: June 18, 1998
Project #: 6863480-R00
File: g:\cpt\silvermet\dwg\reef_mmaf\mm-sht.dwg

Project Title: Final Design
Streamside Tailings Operable Unit
Silver Bow Creek - Subarea I - Reach A

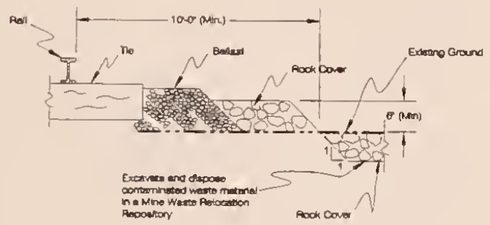
MAXIM TECHNOLOGIES INC

Sheet Title: RR Materials Remediation
SHEET M10d


See Typical Detail A1 for rock cover details on Active Railroad Embankments
See Typical Detail A2 for areas to be amended or revegetated
Excavate the top of the embankment or cut slope to the embankment shoulder and dispose contaminated waste in a Mine Waste Relocation Repository Do not excavate waste material on the slope Place rock directly on top of existing embankment material
Existing Ground
1'-0" (Min.)
Shoulder of Existing Embankment or Cut Slope
Existing Ground
6" (Min.)
6" (Min)
Edge of Waste Material as Determined in Field by the Engineer
6" (Min.)
Railroad Embankment or Cut Slope
Slope of rock cover shall be no steeper than 2 (horiz.):1 (vert.)
See Detail A3 for Edge Detail of Rock
Rock Cover
See Detail A4 for Drainage Ditch at Base of Cut Slope
Existing Ground
1'-0" (Min)
1
1
2
1

Typical Detail A

Rock Cover Material over Waste Material
NTS

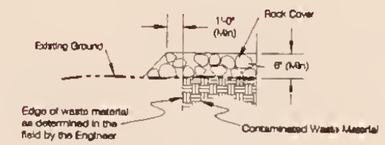


Typical Detail A1

Rock Cover on Top of Active Railroad Embankment
NTS
(For Details not shown, see Detail A)

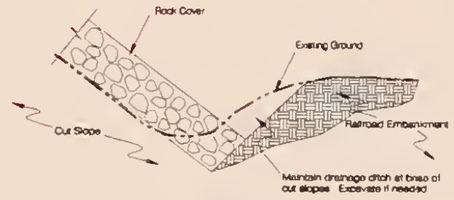
TABLE D
Material Quantity Estimates for Areas U1 and U2
(see notes)

Area	Approx. Volume of Rock Cover
U1	105
U2	30



Detail A3

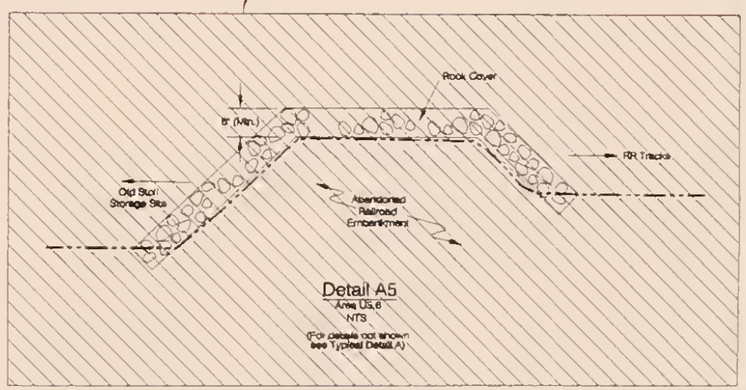
Edge Detail
NTS



Detail A4

Drainage Ditch at Base of Cut Slope
NTS

Not In This Contract



Detail A5

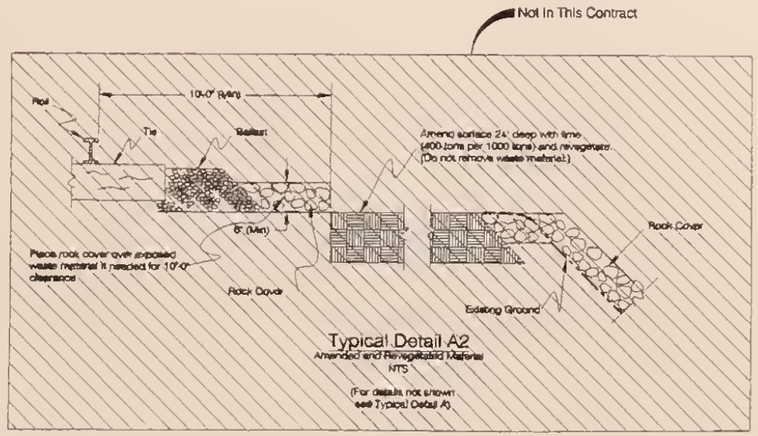
Area U5,6
NTS
(For details not shown see Typical Detail A)

TABLE A
Material Quantity Estimates for Areas Remediated In Accordance with Typical Details A, A1, and A2 and Details A3 - A5 (see notes)

Area	Approx. Volume of Rock Cover (CY)	Approx. Area to be Lime Amended and Revegetated (SF)	Approx. Volume of Contaminated Waste Material to be Excavated and Disposed (CY)
B1/B2	55	—	15
B3	25	—	1
B3.1	45	—	2
B3.2	25	—	1
B3.3	25	—	1
B4	10	—	0.5
B5	10	—	0.5
B6	15	—	0.5
B7	110	—	5
B8	100	—	5
B9	10	—	1
B10	280	—	10
B11	1500	—	100
B12	130	—	15
B13S	310	—	10
B13N	300	—	25
B14S	310	—	10
B14N	180	—	20
B15,5	140	15900	20
B24	520	—	70
B25	240	—	30
B27	440	—	70
B28	800	—	150
B29	340	—	10
B30	35	—	20
B31	140	—	20
B32	110	—	20
B33	35	—	15
B34	310	—	40
B34.5	140	—	30
B34.6	80	—	20
B36	150	—	55
B99	40	—	15
C18	640	—	25
C17	50	—	10
C19.1	100	—	5
C20S	280	—	10
C22S	45	—	2
U4	410	43000	105
U5,6	400	—	0
D6	15	—	5

Not In This Contract

Not In This Contract


Rail
10'-0" (Min.)
Tie
Ballast
Amend surface 24" deep with lime (400 tons per 1000 tons) and revegetate. (Do not remove waste material.)
6" (Min)
Rock Cover
Place rock cover over exposed waste material if needed for 10'-0" clearance
Rock Cover
Existing Ground

Typical Detail A2

Amended and Revegetated Material
NTS
(For details not shown see Typical Detail A)

Notes

1. All Material Quantity Estimates are Approximate and Based on Limited Data. Actual Quantities May Vary. Estimated Quantities are Shown for Cost Estimating Purposes Only.

REV	DATE	DESCRIPTION	DRN BY	APP BY

Date: June 15, 1999
Project #: 9999-999-700
File: g:\remedial\design\final\dtls-1b.dwg

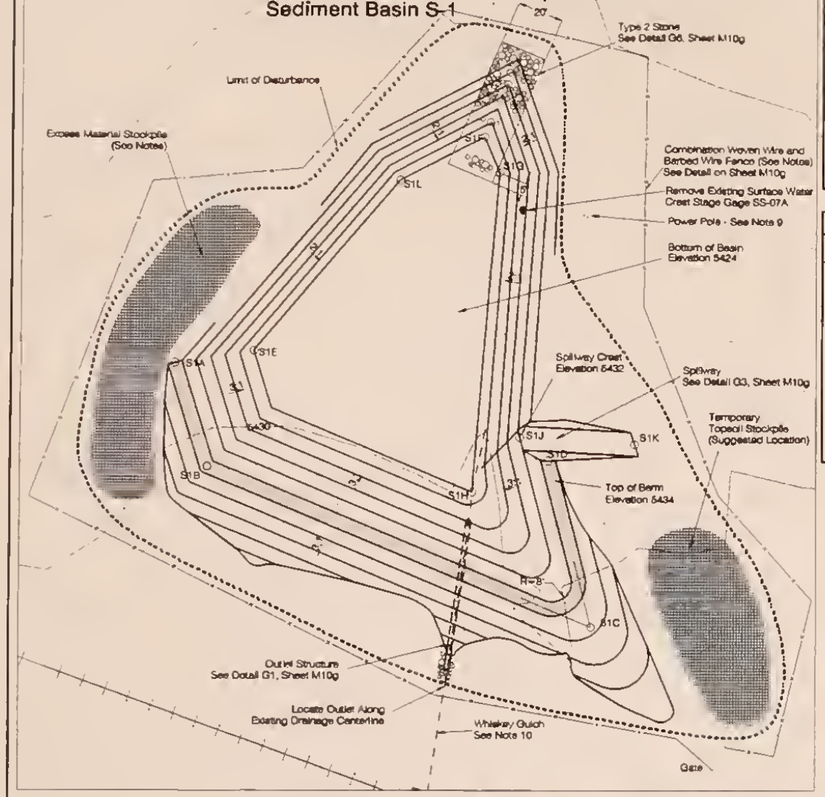
MAXIM TECHNOLOGIES INC

Final Design
Streamside Tailings Operable Unit
Silver Bow Creek - Subarea I - Reach A

RR Materials Remediation
Flood Plain Protection Details

SHEET M10e

Sediment Basin S-1



Sediment Basin S-1		
REFERENCE POINT	EASTING	NORTHING
S1A	1218082.47	744888.71
S1B	1218098.12	744825.22
S1C	1218257.51	744557.78
S1D	1218238.38	744627.63
S1E	1218115.41	744573.96
S1F	1218212.15	744783.97
S1G	1218218.52	744748.76
S1H	1218207.49	744814.44
S1J	1218227.55	744837.35
S1K	1218275.66	744834.46
S1L	1218178.77	744745.77

Sediment Basin S-2

REFERENCE POINT	EASTING	NORTHING
S2A	1217048.47	745344.26
S2B	1217051.07	745319.66
S2C	1217068.74	745258.34
S2D	1217108.17	745259.78
S2E	1217155.69	745321.66
S2F	1217154.27	745332.45
S2G	1217035.08	745244.35
S2H	1217079.25	745278.94
S2J	1217057.46	745326.61
S2K	1217094.15	745365.32
S2L	1217105.86	745414.69
S2M	1217113.69	745416.34
S2N	1217134.10	745337.33
S2O	1217144.56	745345.23
S2P	1217187.21	745328.77
S2Q	1217196.58	745289.47

Sediment Basin S-3

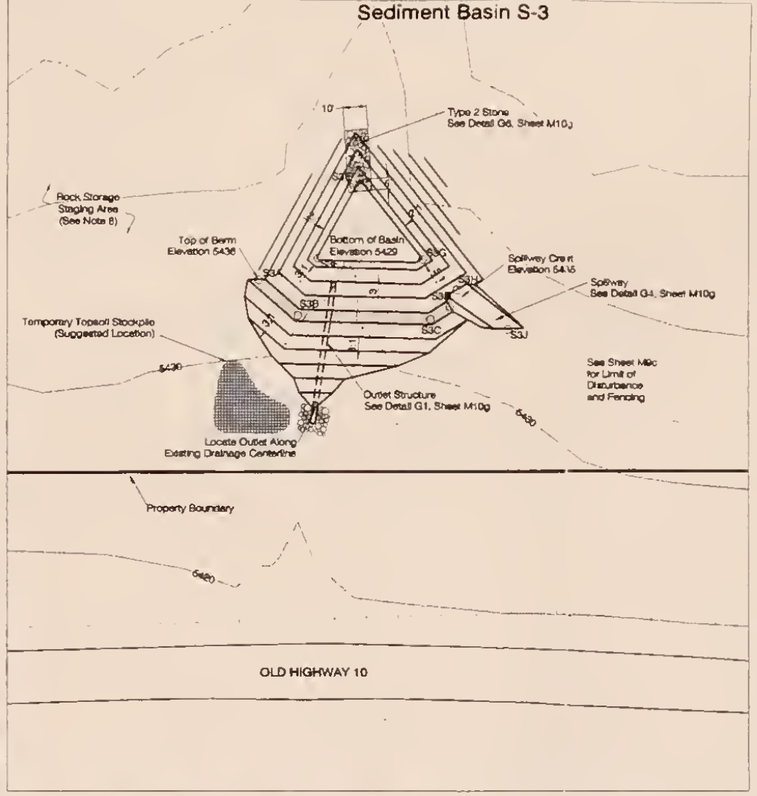
REFERENCE POINT	EASTING	NORTHING
S3A	1215917.57	745372.98
S3B	1215934.20	745357.98
S3C	1215990.53	745356.49
S3D	1215988.88	745382.08
S3E	1215960.01	745415.32
S3F	1215942.66	745382.09
S3G	1215956.96	745381.65
S3H	1216001.75	745389.20
S3J	1216023.47	745352.38

Sediment Basins S-4

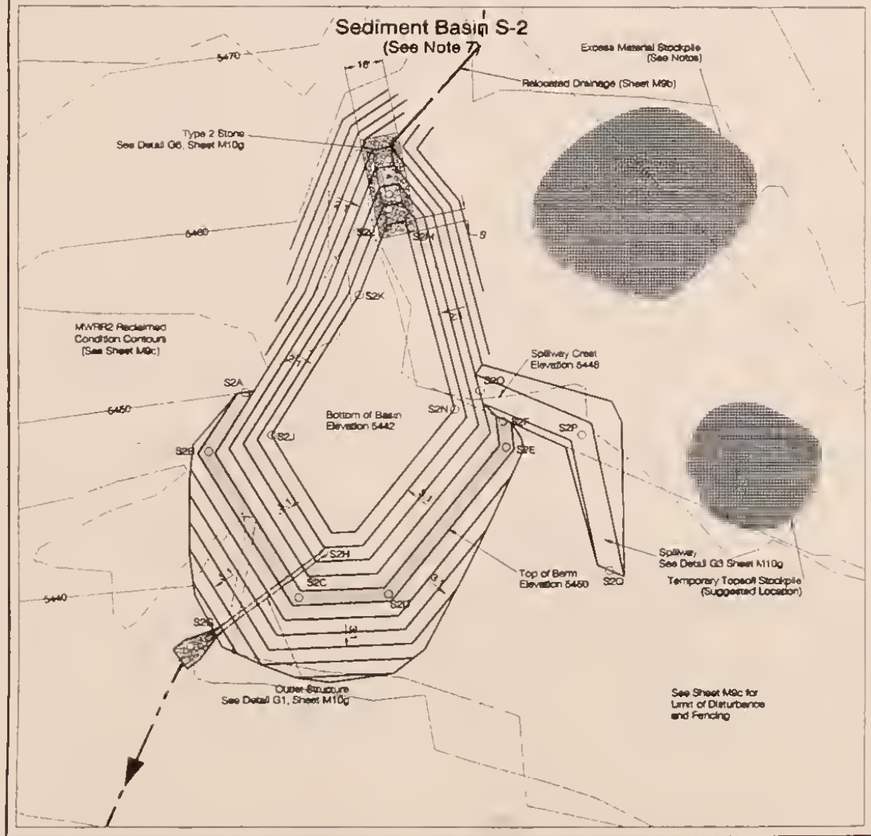
REFERENCE POINT	EASTING	NORTHING
S4A	1215849.00	745382.70
S4B	1215861.00	745376.90
S4C	1215865.00	745380.50
S4D	1215865.47	745411.67
S4E	1215868.00	745380.20
S4F	1215896.00	745378.70
S4G	1215395.00	745348.10
S4H	1215405.00	745318.40
S4J	1215488.00	745376.70
S4K	1215511.80	745344.81
S4L	1215472.64	745339.91
S4M	1215473.82	745350.86
S4N	1215489.00	745346.12
S4O	1215478.87	745356.90
S4P	1215403.32	745339.26
S4Q	1215396.27	745335.37
S4R	1215380.91	745319.92
S4S	1215413.99	745331.39
S4T	1215412.36	745336.02

Not In This Contract

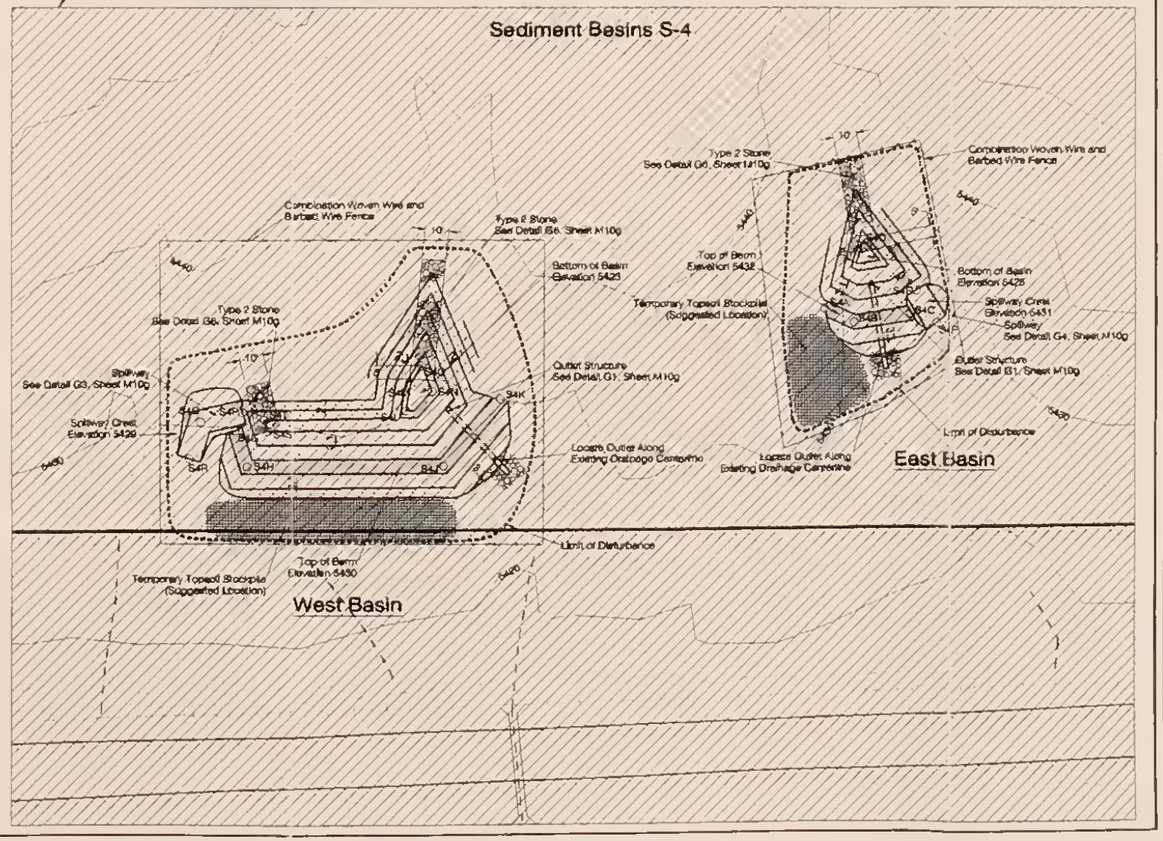
Sediment Basin S-3



Sediment Basin S-2
(See Note 7)



Sediment Basins S-4



NOTES:

1. Top Of Berms Are Shaded Gray.
2. Reference Points On Sediment Basins Are For Horizontal Alignment Only.
3. Reference Points Shown On The Tops Of Berms And Spill Ways Are Located On Centerlines.
4. Combination Woven Wire And Barbed Wire Fence Shall Be 48" High, 32" WW-2BW, Type F-2. Fence Will Be Located In The Field By The Engineer.
5. Excess Material Stockpiles Shall Be Compacted With Rubber-tire Or Tracked Equipment. Piles Shall Be Blended To Existing Topography And New Berms. Piles Shall Be Sloped For Positive Drainage, Covered With Topsoil And Revegetated Locations May Be Modified Based On Site Conditions.
6. Locations Shown For Temporary Topsoil Stockpiles Are Suggested. The Contractor May Use Other Locations At The Approval Of The Engineer.
7. Sediment Basin S-2 Shall Be Constructed After MWRR 2 Has Been Reclaimed. Existing Contours Shown For Basin S-2 Reflect The Reclaimed Condition Of MWRR2. See Sheet M9c.
8. Sediment Basin S-3 Shall Be Constructed After Nearby Rock Storage Stockpiles Have Been Depleted. Storage Staging Fill Shall Be Moved To Approximately Original Contours Prior To Construction Of Basin S-3.
9. At Least Ten (10) Feet Of Clearance Shall Be Maintained Around The Existing Power Poles Near The Basin Site. The Contractor Shall Use Caution While Working Around And Beneath The Existing Overhead Power Lines.
10. Incidental To This Work, The Contractor Shall Temporarily Divert Flows In Whiskey Gulch Around The Construction Area During Construction Activities. Flows Shall Be Directed Into Sediment Basin S-1 After Construction Is Complete

Legend:

S1A-◆ Reference Point

---------- Limit of Disturbance

N

0 Feet 80

Contour Interval = 2 ft

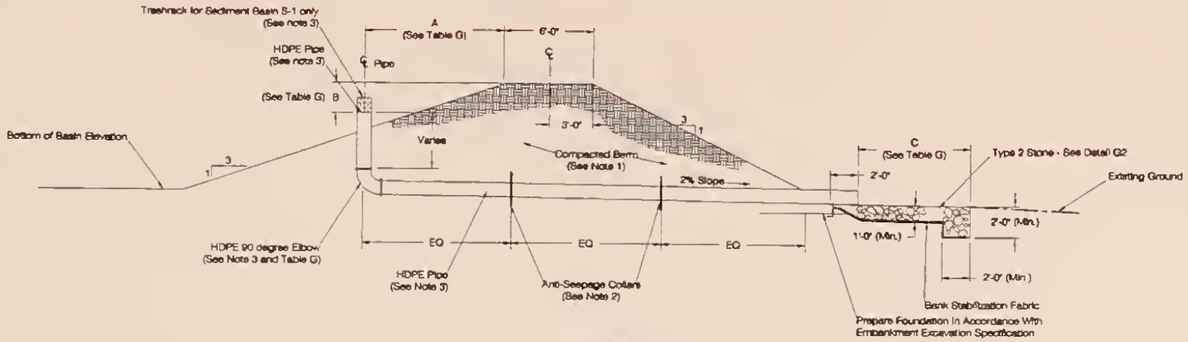
NO.	DATE	DESCRIPTION	DRN. BY	APP. BY

Date: June 14, 1999
Project # 0862-488-100
File: g:\projects\east\dwg\mwrr\mwrrsed02a.dwg

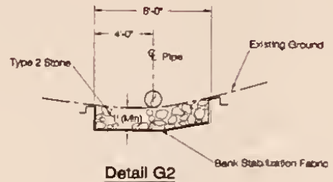
MAXIM TECHNOLOGIES INC

Project Title:
Final Design
Streamside Tailings Operable Unit
Silver Bow Creek - Subarea I - Reach A

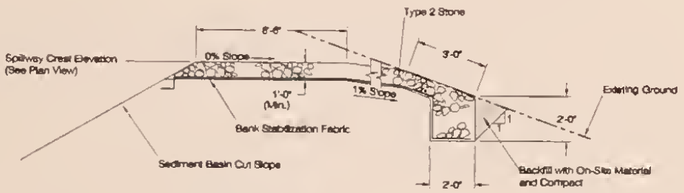
Sheet Title:
RR Materials Remediation
Sediment Basins
SHEET M10f



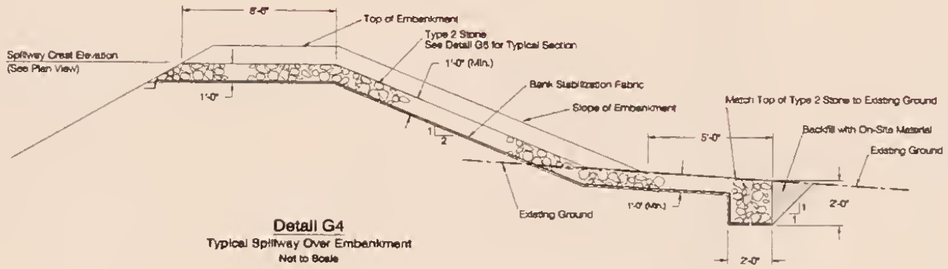
Detail G1
Typical Sediment Basin Berm
Not to Scale



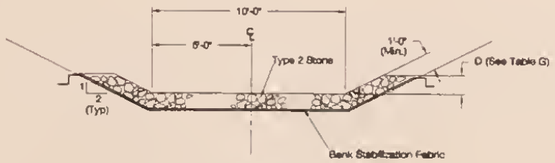
Detail G2
Typical Outlet Stone
Not to Scale



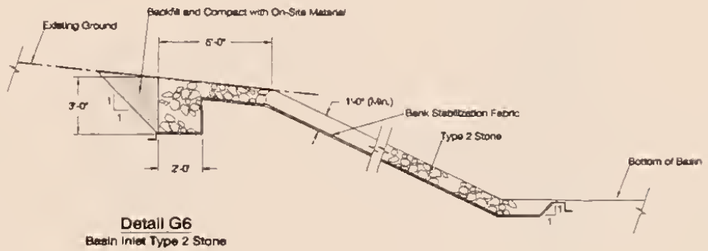
Detail G3
Typical Spillway Profile
Not to Scale



Detail G4
Typical Spillway Over Embankment
Not to Scale



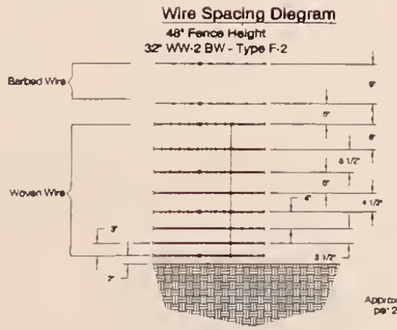
Detail G5
Typical Spillway Section
Not to Scale



Detail G6
Basin Inlet Type 2 Stone
Not to Scale

TABLE G

Basin	A (ft)	B (ft)	C (ft)	D (ft)	
S-1	18	5	12	2	
S-2	18	5	12	2	
S-3	12	3	8	1	
S-4 (both basins)	9	2	8	1	Not in this Contract
S-5	15	4	12	2	
S-6	9	2	8	1	
S-7	9	2	8	1	



Approximate weight of 32" woven wire fabric (832-6-12 1/2) per 20 rod roll is 150 lbs ± 10 lbs. (Note 12 1/2 gage)

• Denotes Staple Locations

Combination Woven Wire and Barbed Wire Fence
Not to Scale

NOTES

1. The Fill For The Berm Shall Be On-Site Materials. Source Of Fill Shall Be From The Basin Excavation. Fill Shall Be Placed As A Structure Embankment And Compacted to 95% Of Maximum Dry Density. Compaction Shall Be 95% Of Maximum Dry Density. Fill Shall Have No Rocks Larger Than 6" Diameter. Each compacted lift shall be scarified to a depth of at least 2 inches prior to the placement of the next lift.

2. Anti-Seepage Collars Shall Be 2'x2' And Compatible With Smooth Or Corrugated Wall Pipe. The Collars Shall Be Anti-Seep Collar By Agri Drain (Adair, Iowa; 1-800-232-4742) Or Equal.

3. Outlet Pipe Shall Be HDPE, Smooth Interior Corrugated, Advanced Drainage Systems, Inc. Type N-12 Or Equal. Pipe And Fittings For All Sediment Basins Shall Be 12" Diameter. Basin S-1 Outlet Pipe Shall Have A Woven Wire Mesh With 2" Openings. No Trash Racks Are Required On The Other Outlet Pipes.

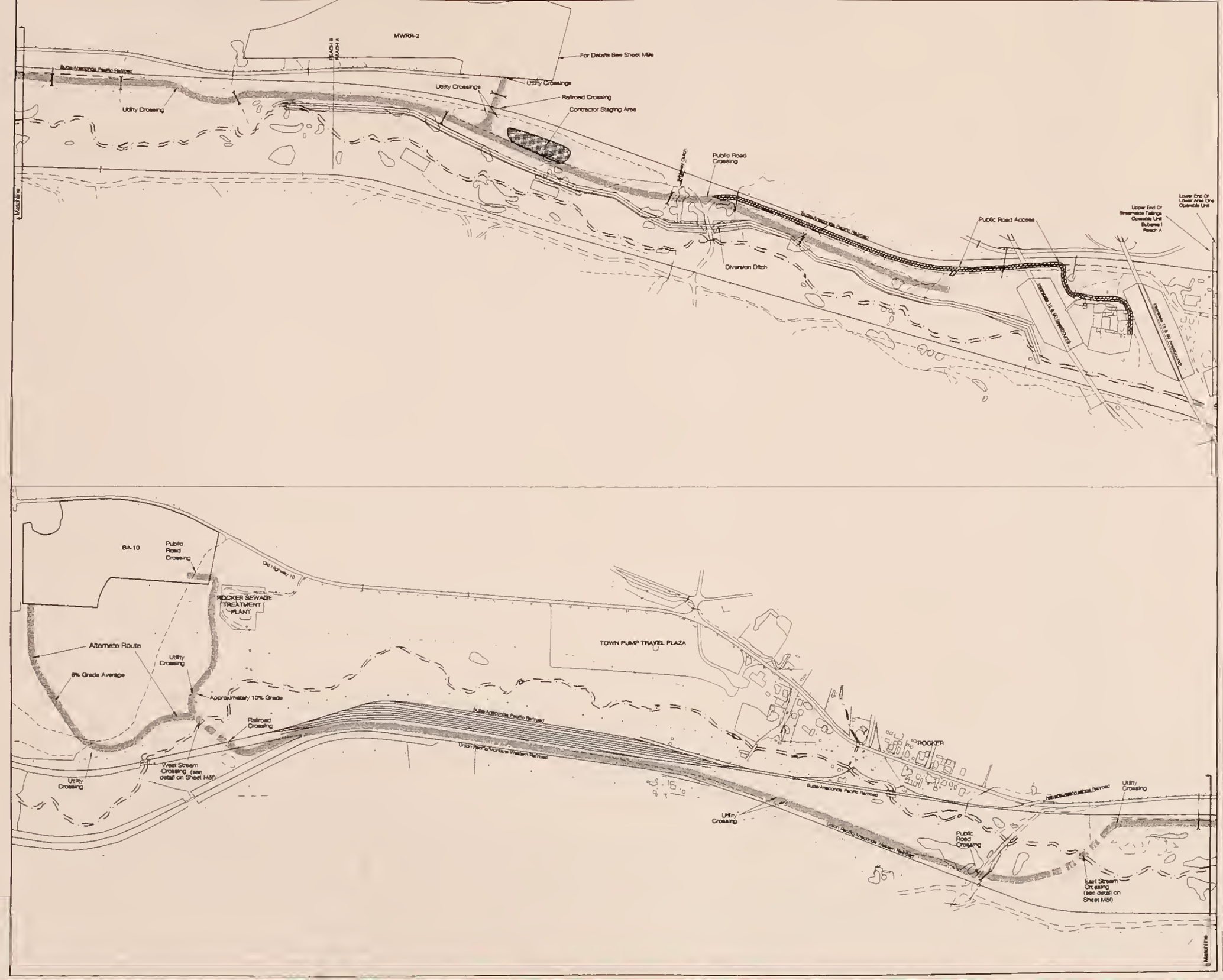
REV	DATE	DESCRIPTION	DRN BY	APP BY

Date: June 18, 1999
Project #: 9999-480.110
File: g:\projects\eastpage\sediment\details.dwg

MAXIM TECHNOLOGIES INC

Project Title:
Final Design
Streamside Tailings Operable Unit
Silver Bow Creek - Subarea I - Reach A

Sheet Title:
RR Materials Remediation
Sediment Basin Details
SHEET M10g



NOTES

1. All Primary Haul Road Locations are Approximate. The Contractor Must Field Verify and Fit Exact Location.

2. All Diversion Channel Crossing Locations Will be Determined by the Contractor and Subject to the Engineers Approval. Diversion Channel Crossing Details are Shown on the Diversion Channel Drawings Sheet I25

3. In Locations Where Haul Roads Cross Areas of Tailings/Impacted Soils the Tailings/Impacted Soils Must be Removed Prior to Placement of Haul Road. Tailings/Impacted Soils are to be Dewatered on Site and Hauled to MWRR2. See Drawing Sheet M5f For Tailings Excavation Depths

4. Utility Crossings Must be Constructed in Accordance with the Utility Owner/Operators Requirements

LEGEND

- Primary Haul Road For Use By On-Road Haul Truck (road improvement may be necessary)
- Primary Haul Road Outside Floodplain
- Primary Haul Road Inside Floodplain
- BA-10 — Borrow Boundary
- MWRR-2 — Mine Waste Relocation Repository Boundary
- Proposed Culvert Installation
- Diversion Channel

N

0 300 600 Feet

REV	DATE	DESCRIPTION	DRN BY	APP BY

Drawn: June 14, 1999
Project #
File:

Project Title: Final Design
Streamside Tailings Operable Unit
Silver Bow Creek - Subarea I - Reach A

Sheet Title: Transportation Plan
SHEET M11

MAXIM TECHNOLOGIES INC

Paved road
Other road
Trail
Railroad
Bridge
Building, Structure, or Concrete Pad

Hydrologic Zone

- Surface Water
- Deepwater Wetland
- Shallow Ponded Wetland
- Saturated Wetland
- Transition Zone
- Subirrigated Zone
- Upland Zone
- Upland with Weedy Seed Bank

Revegetation Plantings

- Deciduous Trees
- Rocky Mountain Juniper
- Willow
- Aspen
- Herbaceous Plugs

Soil Classes (Delineated in red)

1 - BA1 Borrow - In Situ Loamy Sand or Coarser
2 - BA10 Borrow - In Situ Sandy Loam, Silt Loam, Loam, or Sandy Clay
3 - In Situ Soil - Silty Clay Loam, Clay Loam, and Silty Clay
Soil texture in un-numbered areas is unknown.

Contour Interval 2 Feet
(1 foot in floodplain)

Scale in Feet

0 200 400 600 800

Montana State Library
Natural Resource Information System
Map #98deq36a - 06/15/99

Sources:
Base map data was digitized by Horizons, Inc., of Rapid City, SD, from aerial photographs of 1991. Contours digitized by Horizons in 1996. Proposed floodplain contours, location of Silver Bow Creek, and location of the drainage ditch were provided by Interfluve. Wetland classes provided by the Montana Bureau of Mines and Geology. Soil classes by Bighorn Environmental, based on soil data and excavation plan provided by Maxim Technology. Revegetation plan by Bighorn Environmental.

1,000-foot grid is for Montana State Plane Coordinates, South Zone, NAD27.

Revegetation Plan
Preliminary Final Design
Streamside Tailings Operable Unit
Silver Bow Creek Subarea 1, Reach A

Figure J1 –A

1216000

1217000

1218000

745000

744000

Whiskey Gulch

Paved road
Other road
Trail
Railroad
Bridge
Building, Structure, or Concrete Pad

Hydrologic Zone

- Surface Water
- Deepwater Wetland
- Shallow Ponded Wetland
- Saturated Wetland
- Transition Zone
- Subirrigated Zone
- Upland Zone
- Upland with Weedy Seed Bank

Revegetation Plantings

- Deciduous Trees
- Rocky Mountain Juniper
- Willow
- Aspen
- Herbaceous Plugs

Soil Classes (Delineated in red)

1 - BA1 Borrow - In Situ Loamy Sand or Coarser
2 - BA10 Borrow - In Situ Sandy Loam, Silt Loam, Loam, or Sandy Clay
3 - In Situ Soil - Silty Clay Loam, Clay Loam, and Silty Clay
Soil texture in un-numbered areas is unknown.

Contour Interval 2 Feet
(1 foot in floodplain)

Scale in Feet

0 200 400 600 800

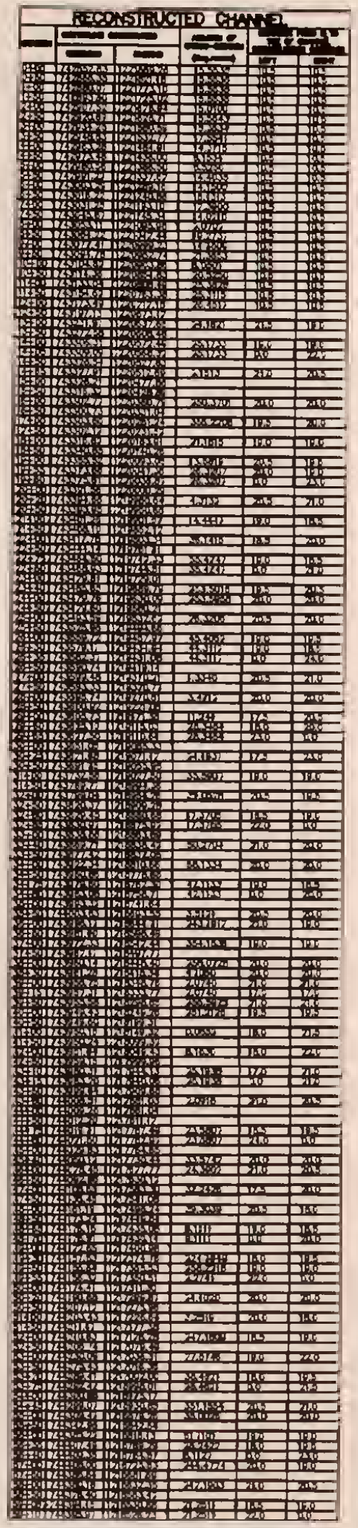
Sources:
Base map data was digitized by Horizons, Inc., of Rapid City, SD, from aerial photographs of 1991. Contours digitized by Horizons in 1996. Proposed floodplain contours, location of Silver Bow Creek, and location of the drainage ditch were provided by Interfluve. Wetland classes provided by the Montana Bureau of Mines and Geology. Soil classes by Bighorn Environmental, based on soil data and excavation plan provided by Maxim Technology. Revegetation plan by Bighorn Environmental

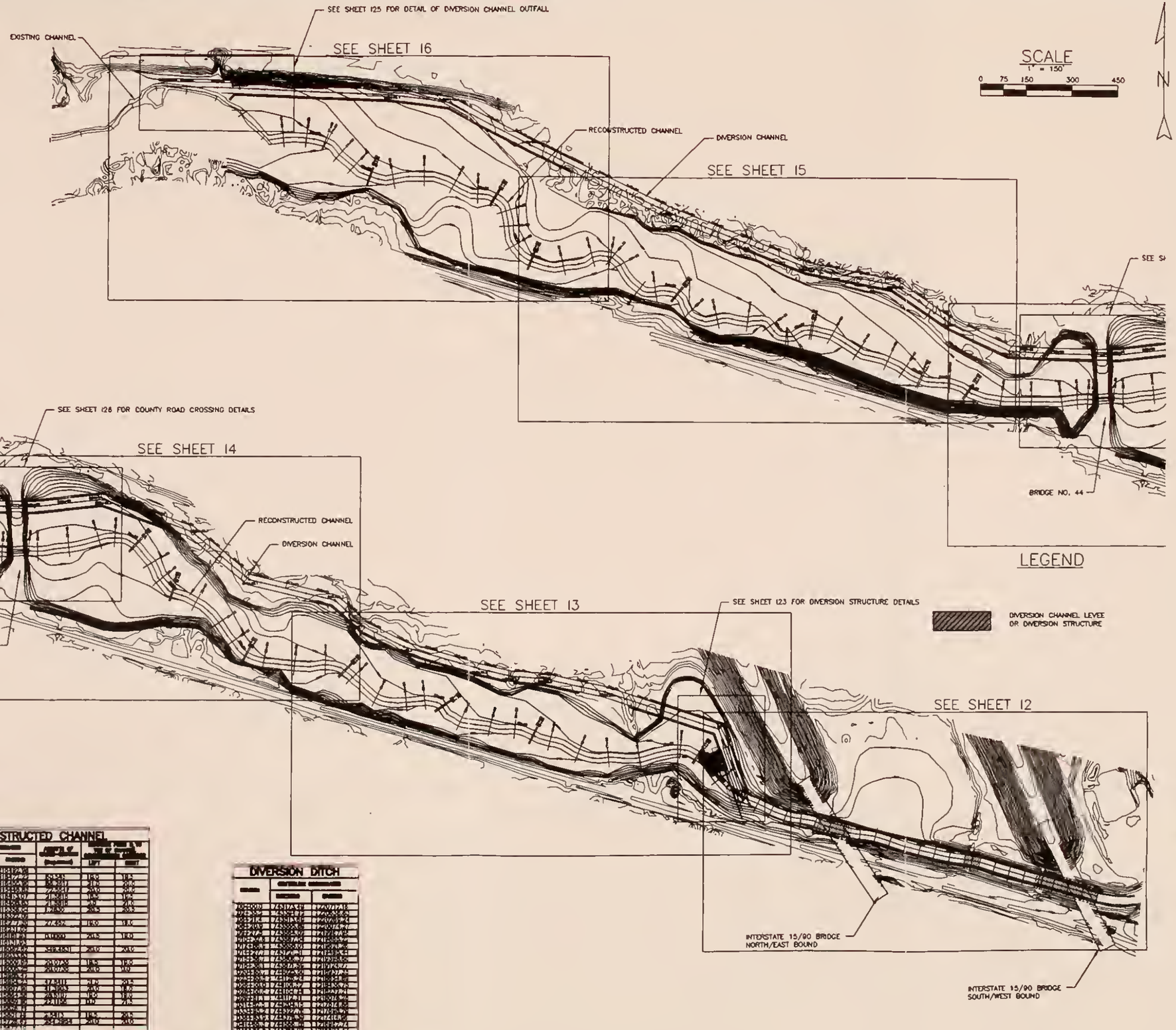
1,000-foot grid is for Montana State Plane Coordinates, South Zone, NAD27.

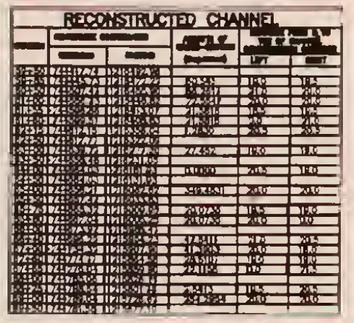
Montana State Library
Natural Resource Information System
Map #98deq36a - 06/15/99

Revegetation Plan
Preliminary Final Design
Streamside Tailings Operable Unit
Silver Bow Creek Subarea 1, Reach A

Figure J1 –B







SITE PLAN OF REACH A

INTER-FLUVE, INC.

BOZEMAN, MONTANA (406) 586-8803 HOOD RIVER, OREGON (541) 386-6333

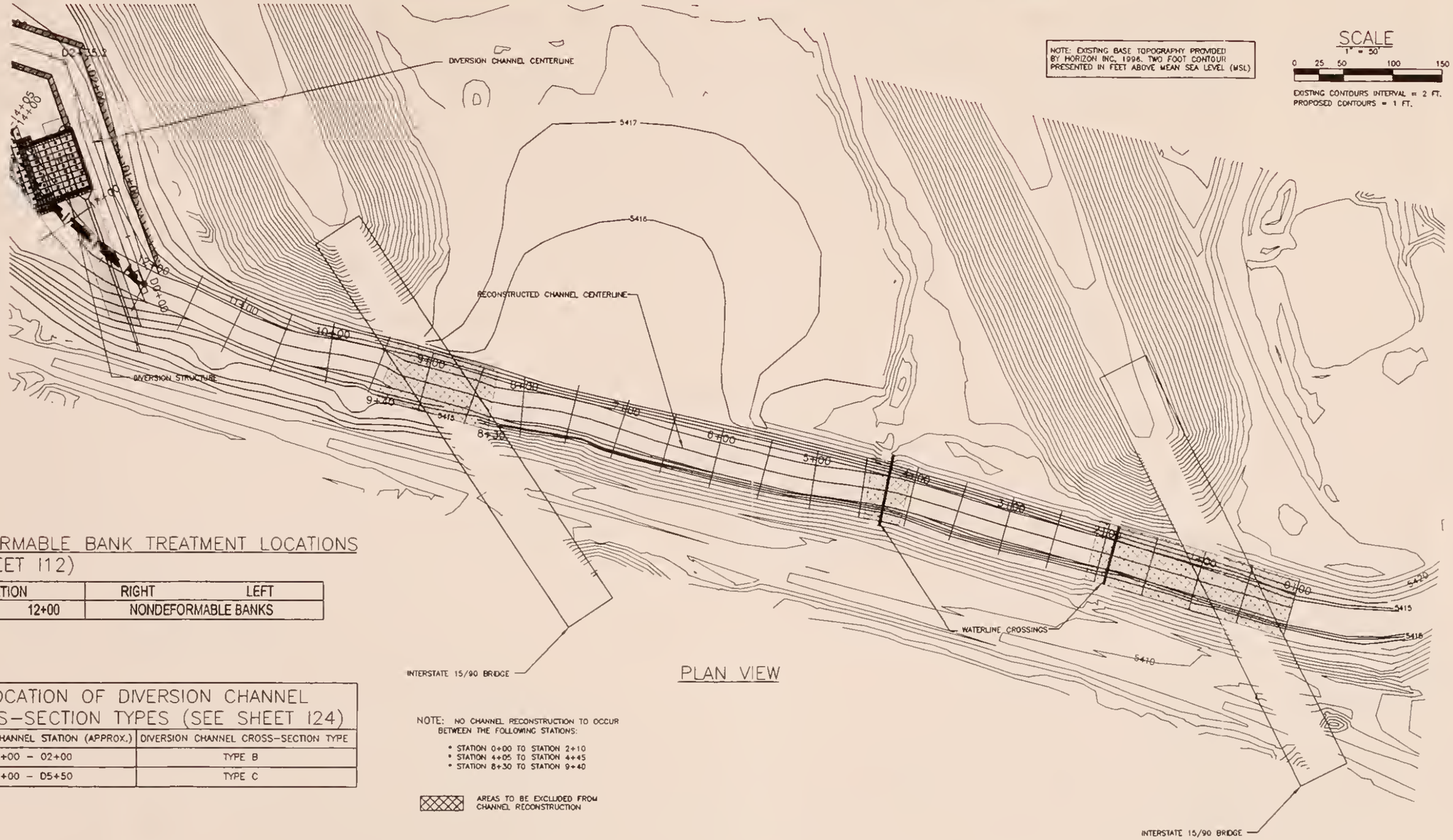
FINAL DESIGN
STREAMSIDE TAILINGS OPERABLE UNIT
SILVER BOW CREEK-SUBAREA 1-REACH A

DESIGNED BY: REP
DATE: 3-2-98

APPROVED BY: MAR
DATE: 06-08-99

DRAWING FILE: 11.DWG
DATE: 06-08-99

SHEET
11 of 127



PLAN VIEW

NONDEFORMABLE BANK TREATMENT LOCATIONS
(SEE SHEET 112)

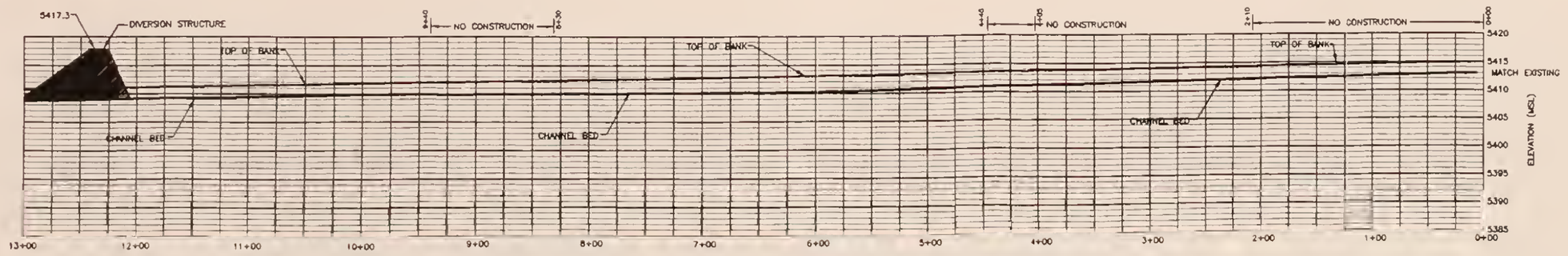
STATION		RIGHT LEFT
0+00	12+00	NONDEFORMABLE BANKS

LOCATION OF DIVERSION CHANNEL CROSS-SECTION TYPES (SEE SHEET 124)	
DIVERSION CHANNEL STATION (APPROX.)	DIVERSION CHANNEL CROSS-SECTION TYPE
D0+00 – 02+00	TYPE B
02+00 – D5+50	TYPE C

NOTE: NO CHANNEL RECONSTRUCTION TO OCCUR BETWEEN THE FOLLOWING STATIONS:

- STATION 0+00 TO STATION 2+10
- STATION 4+05 TO STATION 4+45
- STATION 8+30 TO STATION 9+40

AREAS TO BE EXCLUDED FROM CHANNEL RECONSTRUCTION



LONGITUDINAL PROFILE OF RECONSTRUCTED CHANNEL

PLAN AND PROFILE
RECONST. CHANNEL STA. 0+00–12+00
DIV. CHANNEL STA. D0+00–D2+35.2

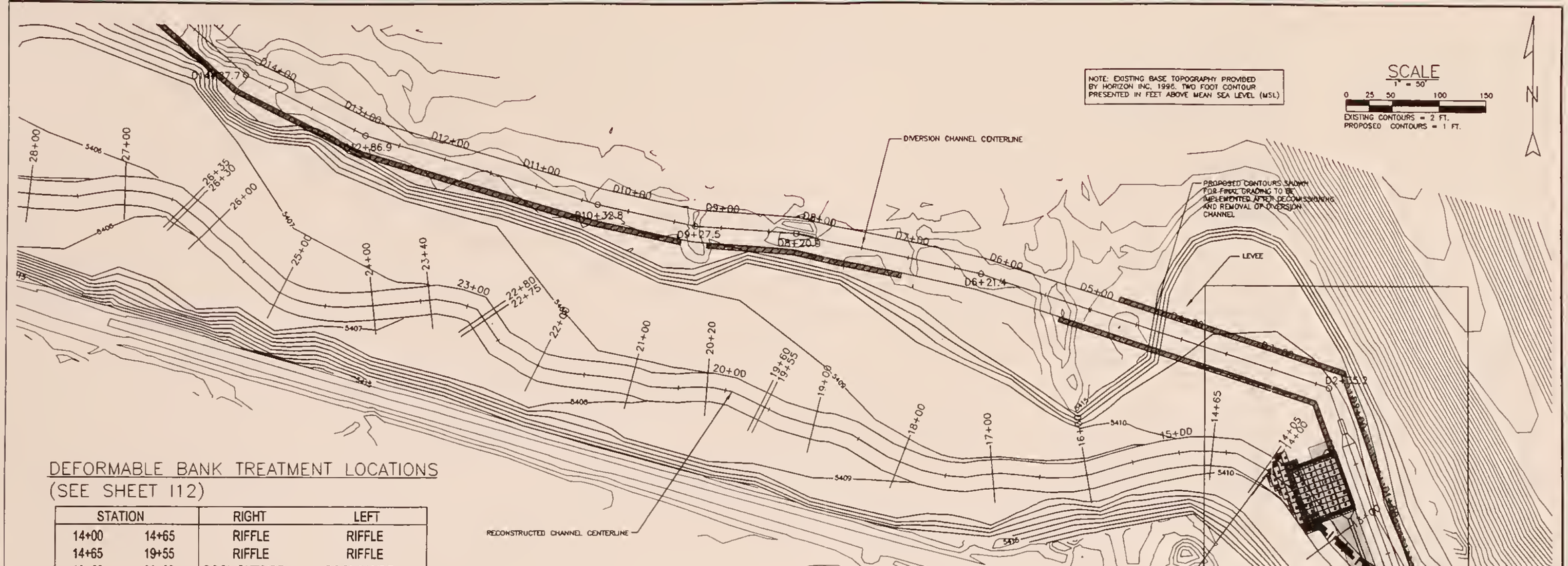
INTER-FLUVE, INC.
BOZEMAN, MONTANA

FINAL DESIGN
STREAMSIDE TAILINGS OPERABLE UNIT
SILVER BOW CREEK–SUBAREA 1–REACH A

REVISED BY/DATE	REMARKS

DRAWN BY: REP
DATE: 3-2-98
APPROVED BY: MAR
DATE: 06-07-99
DRAWING FILE: 12.DWG
DATE: 06-07-99

SHEET:
12 OF 127



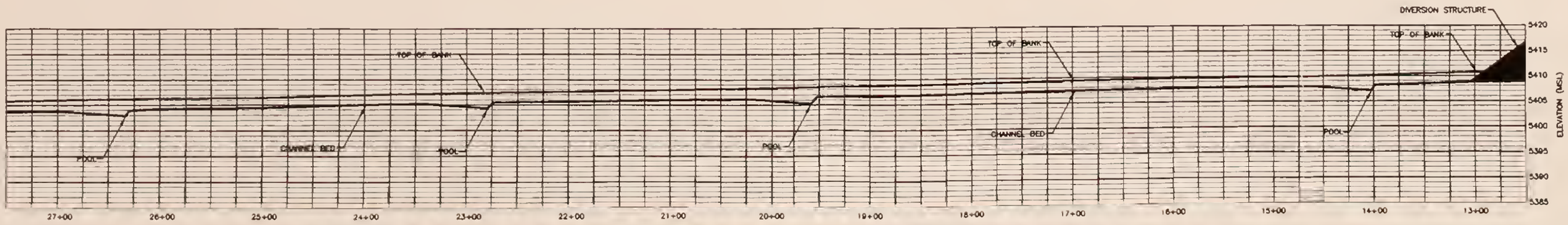
PLAN VIEW

DEFORMABLE BANK TREATMENT LOCATIONS
(SEE SHEET 112)

STATION		RIGHT	LEFT
14+00	14+65	RIFFLE	RIFFLE
14+65	19+55	RIFFLE	RIFFLE
19+55	20+20	POOL OUTSIDE	POOL INSIDE
20+20	22+75	RIFFLE	RIFFLE
22+75	23+40	POOL OUTSIDE	POOL INSIDE
23+40	26+30	RIFFLE	RIFFLE
26+30	27+00	POOL OUTSIDE	POOL INSIDE
27+00	29+60	RIFFLE	RIFFLE

LOCATION OF DIVERSION CHANNEL CROSS-SECTION TYPES (SEE SHEET 124)

DIVERSION CHANNEL STATION (APPROX.)	DIVERSION CHANNEL CROSS-SECTION TYPE
D0+00 - D2+00	TYPE B
D2+00 - D5+50	TYPE C
D5+50 - D10+25	TYPE A
D10+25 - D18+00	TYPE B



LONGITUDINAL PROFILE OF RECONSTRUCTED CHANNEL

PLAN AND PROFILE
RECONST. CHANNEL STA.14+00-28+00
DIV. CHANNEL STA. D+00-D14+27.7

INTER-FLUVE, INC.

FINAL DESIGN
STREAMSIDE TAILINGS OPERABLE UNIT
SILVER BOW CREEK-SUBAREA 1-REACH A

REVISED BY/DATE | REVISION

Drawn BY: REP
Date: 3-2-98
Approved BY: MAR
Date: 06-07-99
File: 13.DWG
Date: 06-07-99

SHEET
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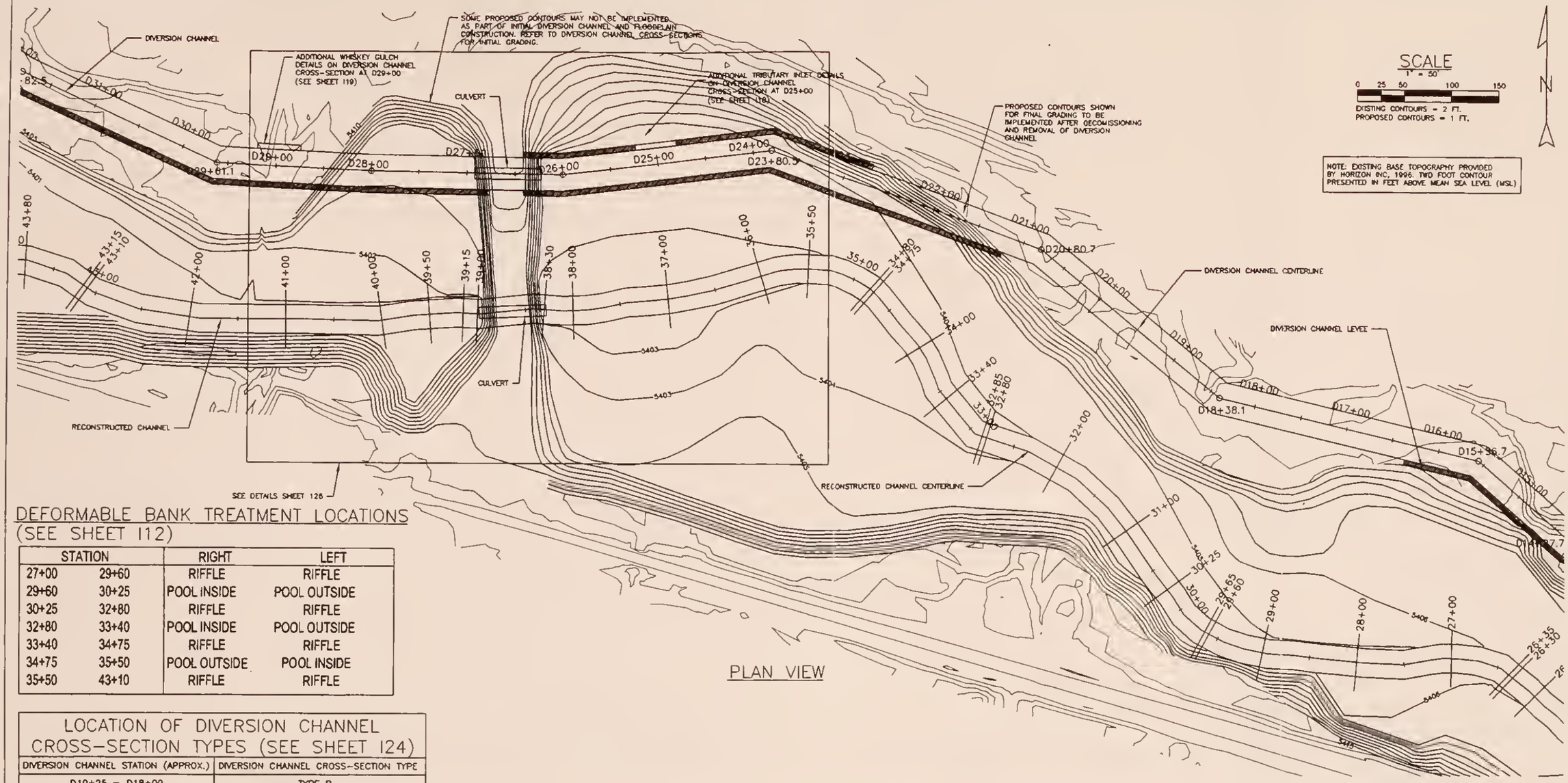


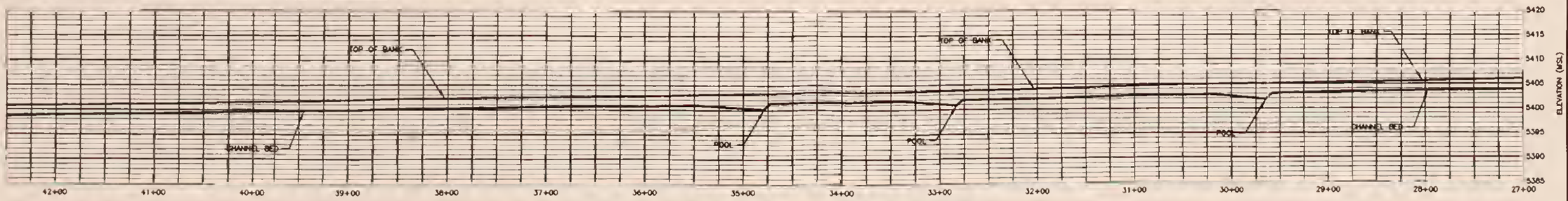
PLAN VIEW

DEFORMABLE BANK TREATMENT LOCATIONS (SEE SHEET 112)

STATION		RIGHT	LEFT
27+00	29+60	RIFFLE	RIFFLE
29+60	30+25	POOL INSIDE	POOL OUTSIDE
30+25	32+80	RIFFLE	RIFFLE
32+80	33+40	POOL INSIDE	POOL OUTSIDE
33+40	34+75	RIFFLE	RIFFLE
34+75	35+50	POOL OUTSIDE	POOL INSIDE
35+50	43+10	RIFFLE	RIFFLE

LOCATION OF DIVERSION CHANNEL CROSS-SECTION TYPES (SEE SHEET 124)

DIVERSION CHANNEL STATION (APPROX.)	DIVERSION CHANNEL CROSS-SECTION TYPE
D10+25 – D18+00	TYPE B
D18+00 – D21+00	TYPE A
D21+00 – D23+75	TYPE B
D23+75 – D29+25	TYPE C



LONGITUDINAL PROFILE OF RECONSTRUCTED CHANNEL

PLAN AND PROFILE
RECONST. CHANNEL STA. 26+30–43+80
DIV. CHANNEL STA. D14+27.7–D31+50

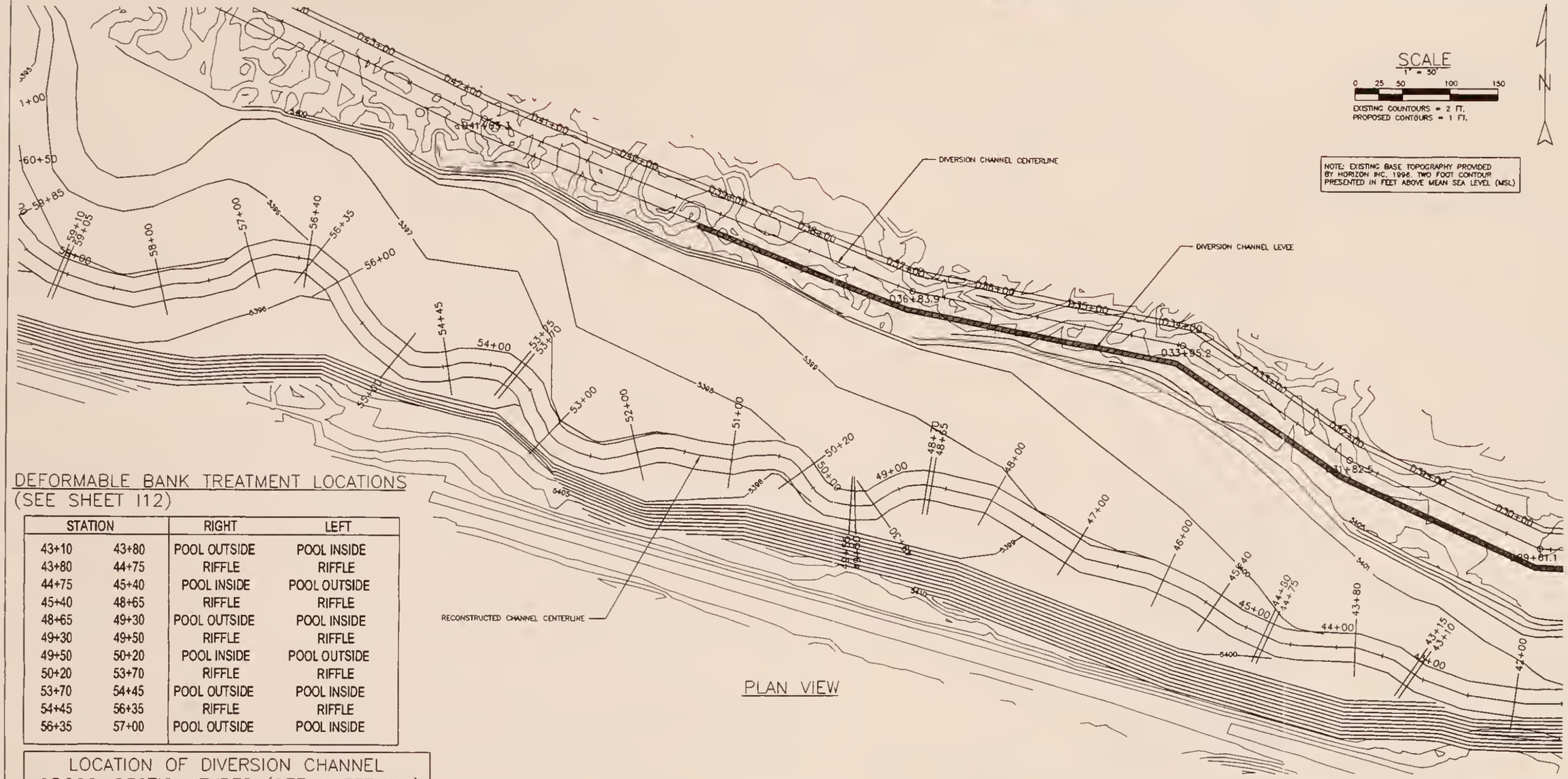
INTER-FLUVE, INC.
BOZEMAN, MONTANA (406) 586-0619 19000 RIVER, OREGON (541) 388-0033

FINAL DESIGN
STREAMSIDE TAILINGS OPERABLE UNIT
SILVER BOW CREEK-SUBAREA 1-REACH A

NO.	DATE	REVISION	BY

DRAWN BY: REP
DATE: 3-2-98
APPROVED BY: MAR
DATE: 06-08-99
DRAWING FILE: 14.DWG
DATE: 06-08-99

SHEET: 14 OF 127


SCALE
1" = 50'
0 25 50 100 150
EXISTING COUNTOURS = 2 FT.
PROPOSED CONTOURS = 1 FT.
NOTE: EXISTING BASE TOPOGRAPHY PROVIDED BY HORIZON INC. 1996. TWO FOOT CONTOUR PRESENTED IN FEET ABOVE MEAN SEA LEVEL (MSL)
DIVERSION CHANNEL CENTERLINE
DIVERSION CHANNEL LEVEE
RECONSTRUCTED CHANNEL CENTERLINE
N

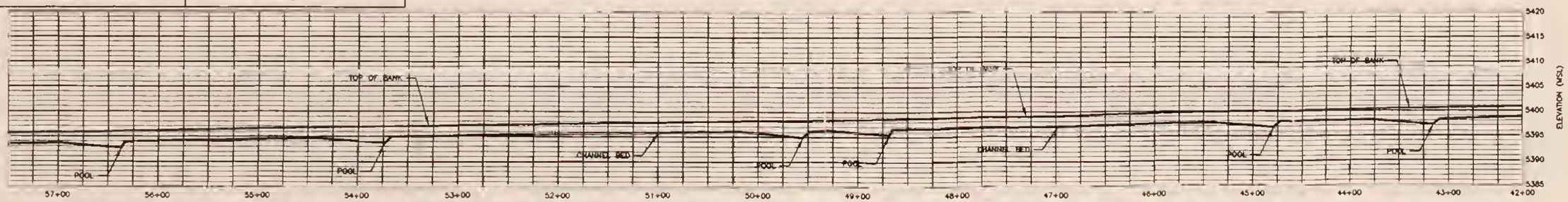
PLAN VIEW

DEFORMABLE BANK TREATMENT LOCATIONS
(SEE SHEET 112)

STATION		RIGHT	LEFT
43+10	43+80	POOL OUTSIDE	POOL INSIDE
43+80	44+75	RIFFLE	RIFFLE
44+75	45+40	POOL INSIDE	POOL OUTSIDE
45+40	48+65	RIFFLE	RIFFLE
48+65	49+30	POOL OUTSIDE	POOL INSIDE
49+30	49+50	RIFFLE	RIFFLE
49+50	50+20	POOL INSIDE	POOL OUTSIDE
50+20	53+70	RIFFLE	RIFFLE
53+70	54+45	POOL OUTSIDE	POOL INSIDE
54+45	56+35	RIFFLE	RIFFLE
56+35	57+00	POOL OUTSIDE	POOL INSIDE

LOCATION OF DIVERSION CHANNEL CROSS-SECTION TYPES (SEE SHEET 124)

DIVERSION CHANNEL STATION (APPROX.)	DIVERSION CHANNEL CROSS-SECTION TYPE
029+25 - 042+00	TYPE B
042+00 - 046+00	TYPE A



LONGITUDINAL PROFILE OF RECONSTRUCTED CHANNEL

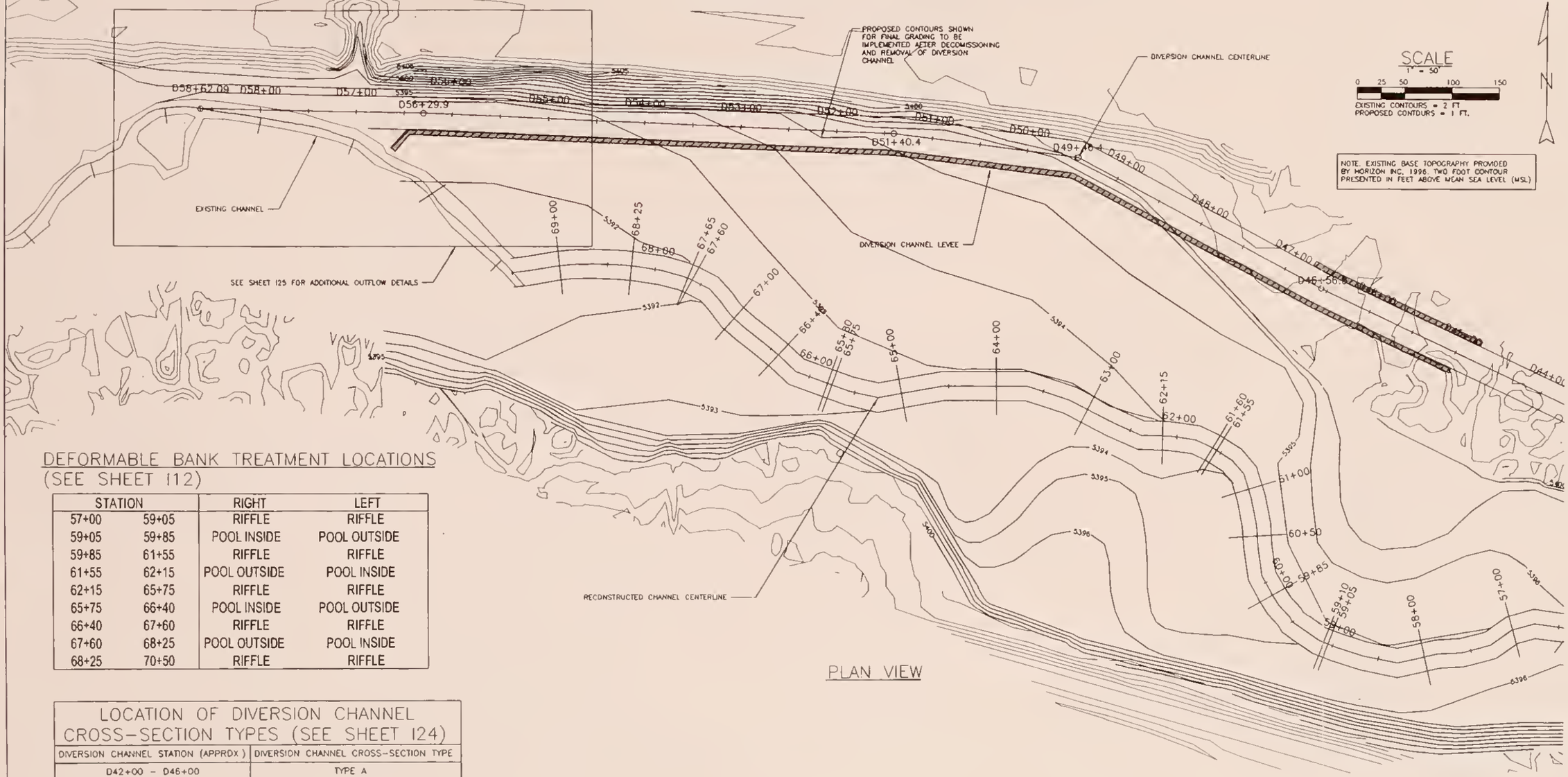
PLAN AND PROFILE
RECONST. CHANNEL STA. 42+00-59+10
DIV. CHANNEL D29+61.1-43+50

INTER-FLUVE, INC.
BOZEMAN, MONTANA (406) 586-8824 HOOD RIVER, OREGON (541) 386-9003

FINAL DESIGN
STREAMSIDE TAILINGS OPERABLE UNIT
SILVER BOW CREEK-SUBAREA 1-REACH A

DESIGNED BY: RCP
DATE: 3-2-98
APPROVED BY: MAR
DATE: 06-08-99
DRAWING FILE: 115.DWG
DATE: 06-08-99

SHEET:
15 of 127



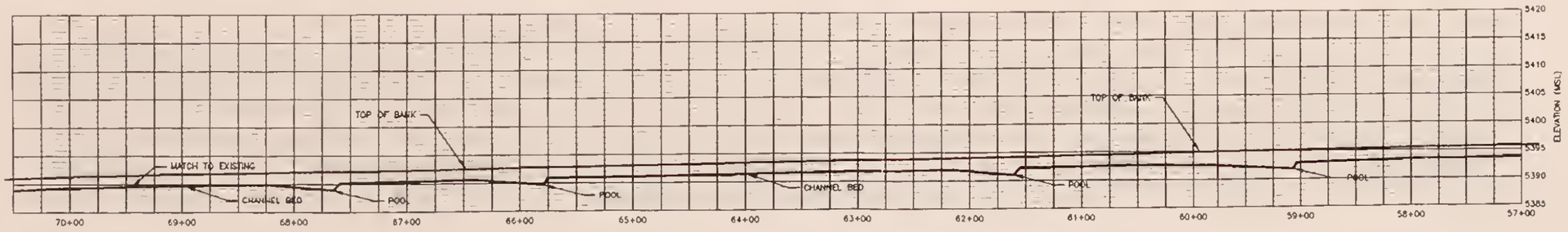
PLAN VIEW

DEFORMABLE BANK TREATMENT LOCATIONS (SEE SHEET 112)

STATION		RIGHT	LEFT
57+00	59+05	RIFFLE	RIFFLE
59+05	59+85	POOL INSIDE	POOL OUTSIDE
59+85	61+55	RIFFLE	RIFFLE
61+55	62+15	POOL OUTSIDE	POOL INSIDE
62+15	65+75	RIFFLE	RIFFLE
65+75	66+40	POOL INSIDE	POOL OUTSIDE
66+40	67+60	RIFFLE	RIFFLE
67+60	68+25	POOL OUTSIDE	POOL INSIDE
68+25	70+50	RIFFLE	RIFFLE

LOCATION OF DIVERSION CHANNEL CROSS-SECTION TYPES (SEE SHEET 124)

DIVERSION CHANNEL STATION (APPROX.)	DIVERSION CHANNEL CROSS-SECTION TYPE
D42+00 - D46+00	TYPE A
D46+00 - D56+75	TYPE B



LONGITUDINAL PROFILE OF RECONSTRUCTED CHANNEL

PLAN AND PROFILE
RECONST. CHANNEL STA. 57+00-69+50
DIV. CHANNEL STA. D44+00-D58+62.09

INTER-FLUVE, INC.
BOZEMAN, MONTANA (406) 586-0626 HOOD RIVER, OREGON (541) 386-9003

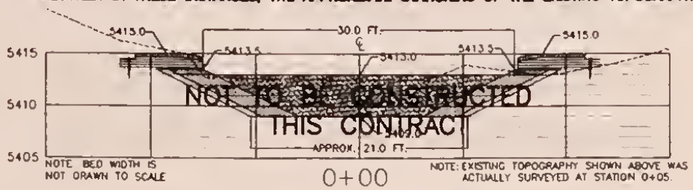
FINAL DESIGN
STREAMSIDE TAILINGS OPERABLE UNIT
SILVER BOW CREEK-SUBAREA 1-REACH A

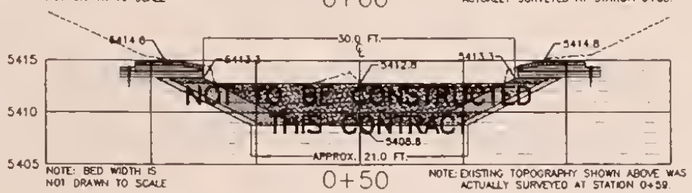
REVISED BY/DATE	REVISION FOR

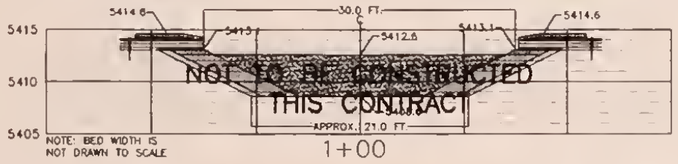
DRAWN BY: REP
DATE: 3-2-98
APPROVED BY: MAR
DATE: 06-08-99
DRAWING FILE: 16.DWG
DATE: 06-08-99

SHEET
16 of 127

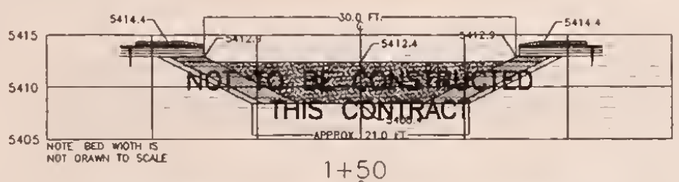
NOTE: EXISTING TOPOGRAPHY WAS NOT SURVEYED AT EVERY CROSS-SECTION. THE LOCATION OF EXISTING TOPOGRAPHY SHOWN BELOW DOES NOT NECESSARILY COINCIDE WITH THE CROSS-SECTION ON WHICH IT IS PLOTTED. IN THESE INSTANCES, THE APPROXIMATE STATIONING OF THE EXISTING TOPOGRAPHY IS NOTED.


NOT TO BE CONSTRUCTED THIS CONTRACT
NOTE: BED WIDTH IS NOT DRAWN TO SCALE
NOTE: EXISTING TOPOGRAPHY SHOWN ABOVE WAS ACTUALLY SURVEYED AT STATION 0+05.
0+00

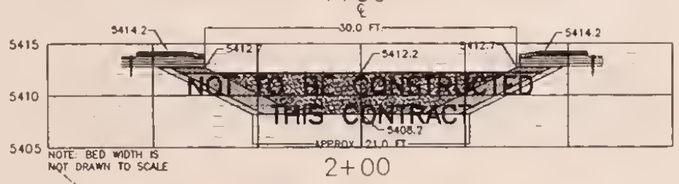

NOT TO BE CONSTRUCTED THIS CONTRACT
NOTE: BED WIDTH IS NOT DRAWN TO SCALE
NOTE: EXISTING TOPOGRAPHY SHOWN ABOVE WAS ACTUALLY SURVEYED AT STATION 0+59.
0+50



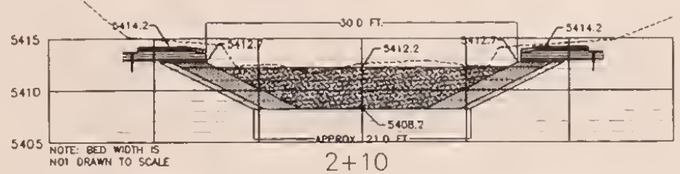
1+00



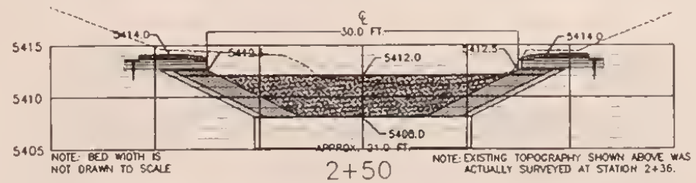
1+50

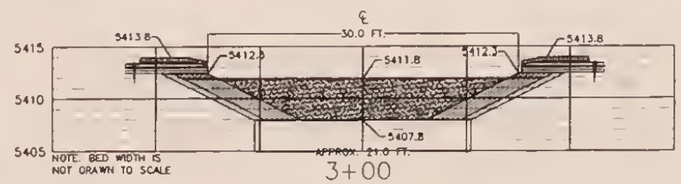


2+00

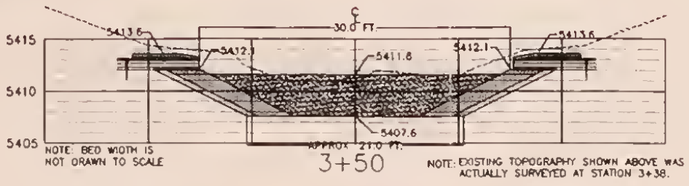


2+10

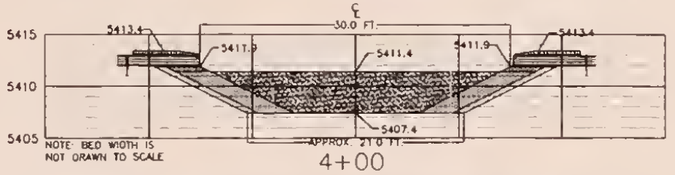

NOT TO BE CONSTRUCTED THIS CONTRACT
NOTE: BED WIDTH IS NOT DRAWN TO SCALE
NOTE: EXISTING TOPOGRAPHY SHOWN ABOVE WAS ACTUALLY SURVEYED AT STATION 2+36.
2+50



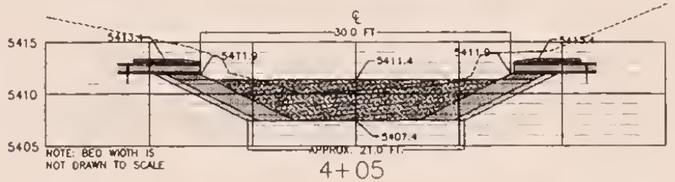
3+00



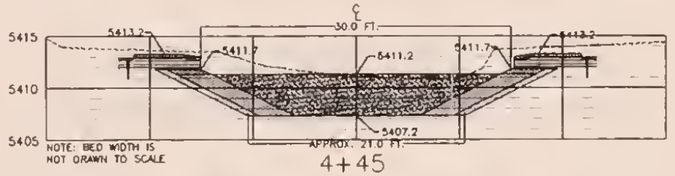
3+50



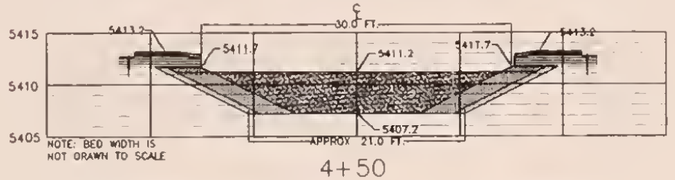
4+00



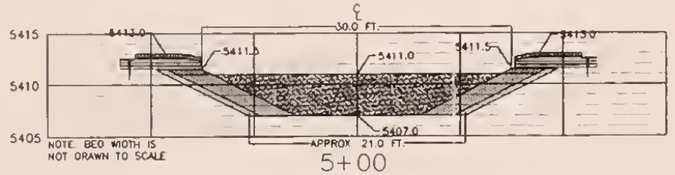
4+05



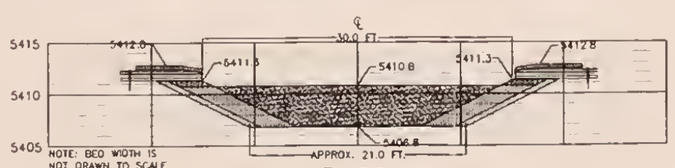
4+45



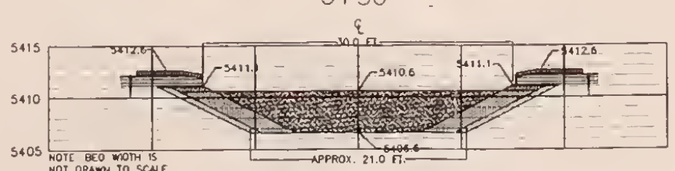
4+50



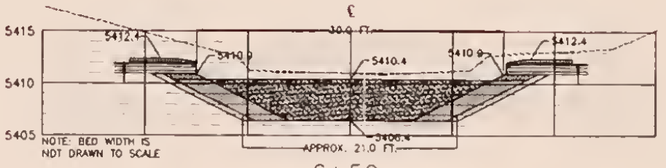
5+00



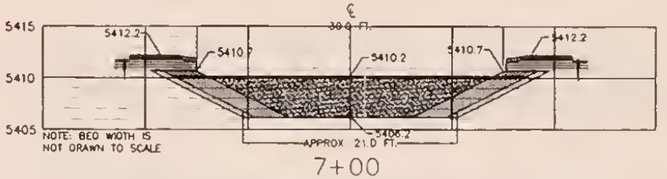
5+50



6+00



6+50



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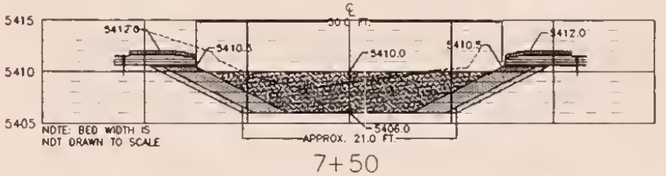
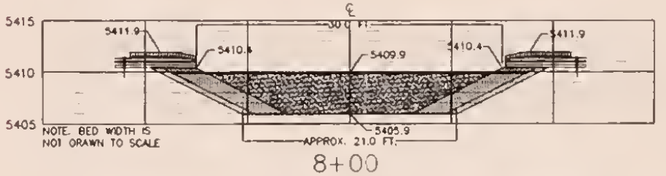
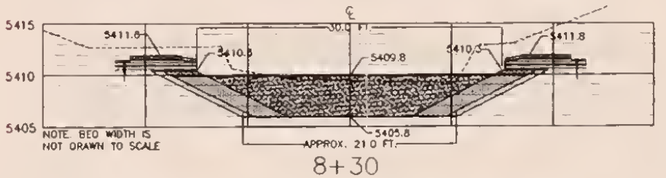


7+50

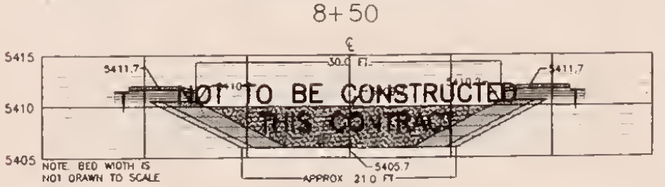


8+00

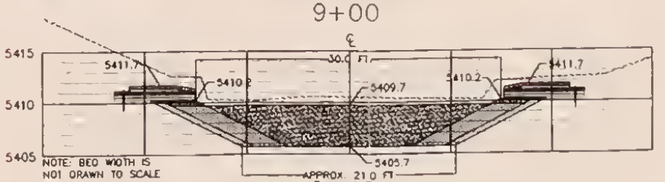


8+30

8+50



9+00



9+40

NOTE: SEE TYPICAL BANK DETAILS OF CROSS-SECTIONS FOR SLOPES (SHEET 112)

RECONSTRUCTED CHANNEL
CROSS SECTIONS
STATIONS 0+00 TO 11+50

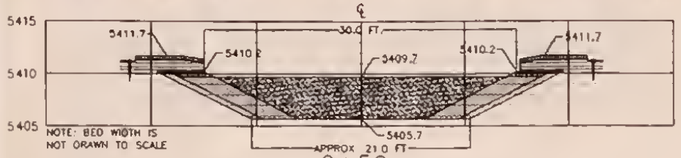
INTER-FLUVE, INC.
BOZEMAN, MONTANA (406) 585-0825 HOOD RIVER, OREGON (541) 386-9003

FINAL DESIGN
STREAMSIDE TAILINGS OPERABLE UNIT
SILVER BOW CREEK-SUBAREA 1-REACH A

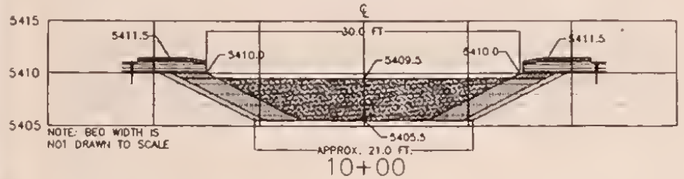
DRAWN BY: REP
DATE: 3-2-98
APPROVED BY: MAR
DATE: 06-08-99
DRAWING FILE: 17.DWG
DATE: 06-08-99

SHEET:
17 of 127

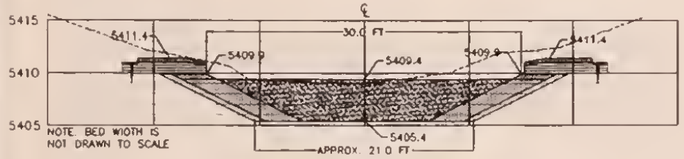
NOTE: EXISTING TOPOGRAPHY WAS NOT SURVEYED AT EVERY CROSS-SECTION. THE LOCATION OF EXISTING TOPOGRAPHY SHOWN BELOW DOES NOT NECESSARILY COINCIDE WITH THE CROSS-SECTION ON WHICH IT IS PLOTTED. IN THESE INSTANCES, THE APPROXIMATE STATIONING OF THE EXISTING TOPOGRAPHY IS NOTED.



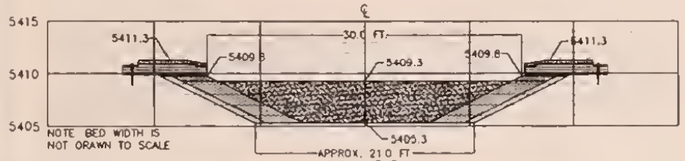
9+50



10+00

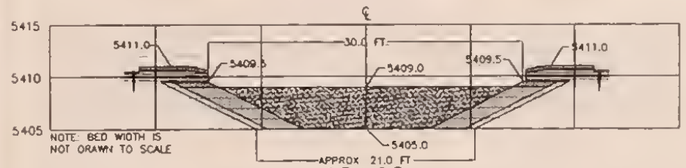


10+50

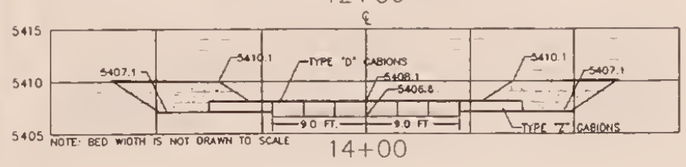


11+00

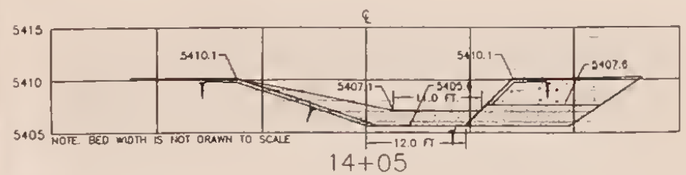
11+50



12+00



14+00



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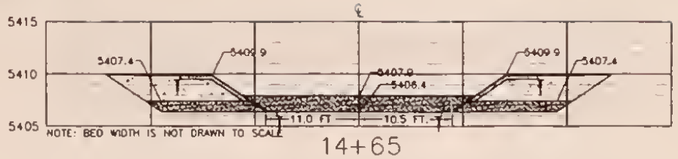

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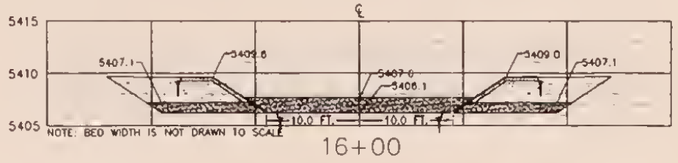
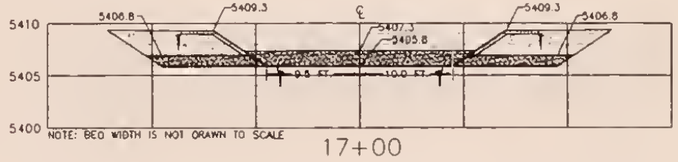
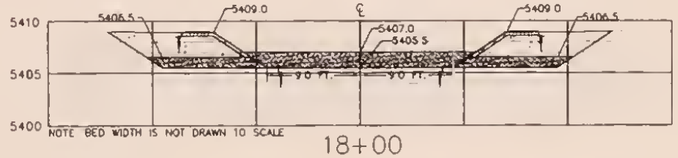


16+00

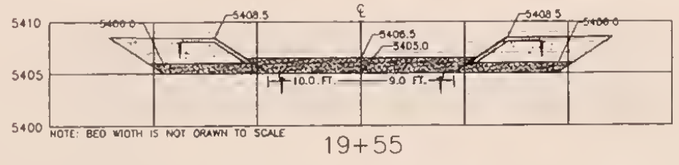


17+00

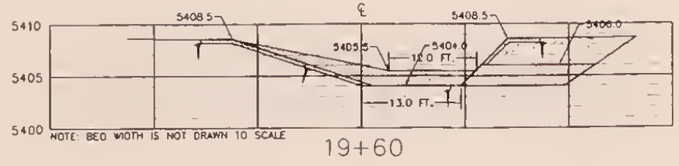


18+00

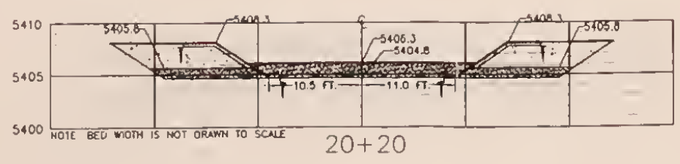
19+00



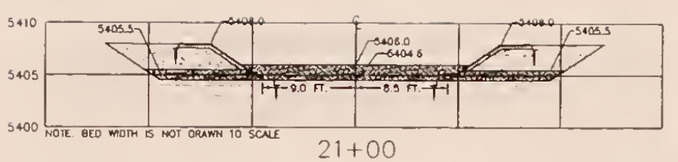
19+55



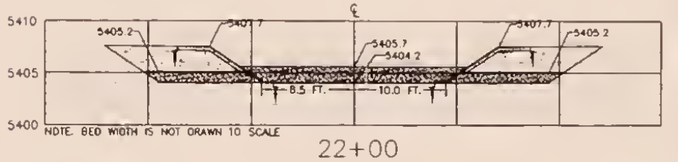
19+60



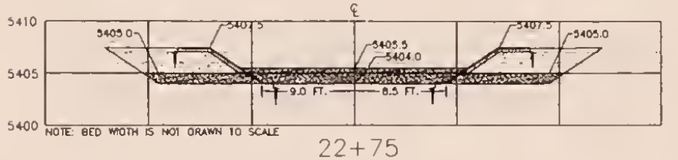
20+20



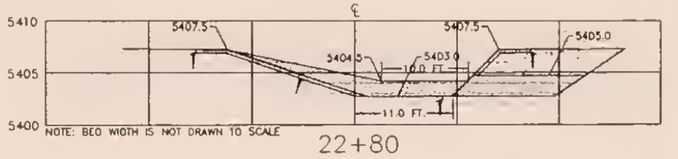
21+00



22+00

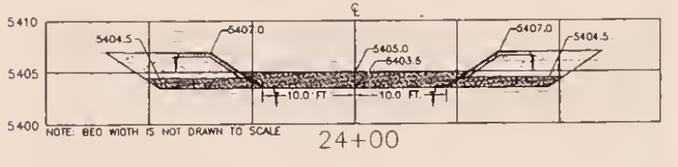


22+75

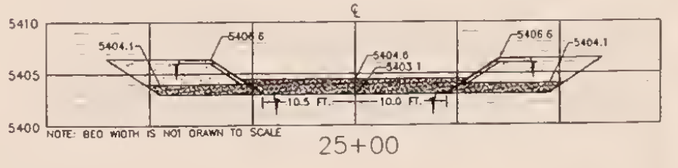


22+80

23+40



24+00



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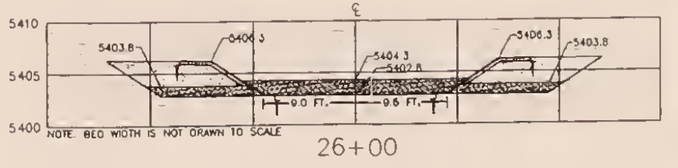


26+00

NOTE: SEE TYPICAL BANK DETAILS OF CROSS-SECTIONS FOR SLOPES (SHEET 112)

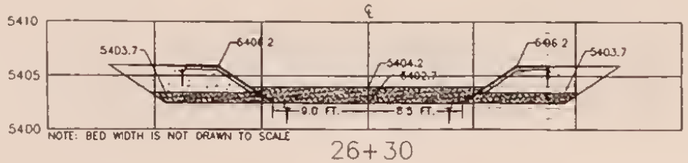
RECONSTRUCTED CHANNEL
CROSS SECTIONS
STATIONS 12+00 TO 28+00

INTEK-FLUVE, INC.
BOZEMAN, MONTANA

FINAL DESIGN
STREAMSIDE TAILINGS OPERABLE UNIT
SILVER BOW CREEK-SUBAREA 1-REACH A

DRAWN BY: REP
DATE: 3-2-98
APPROVED BY: MAR
DATE: 06-08-99
DRAWING FILE: 18.DWG
DATE: 06-08-99

SHEET:
18 of 127



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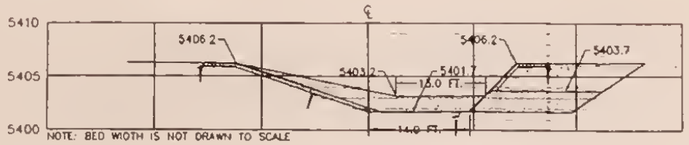

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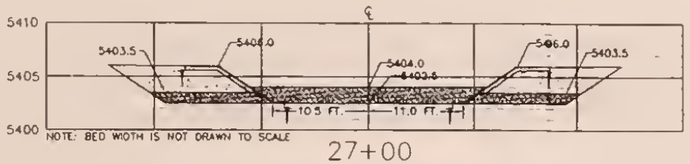
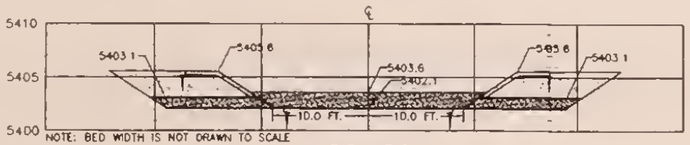
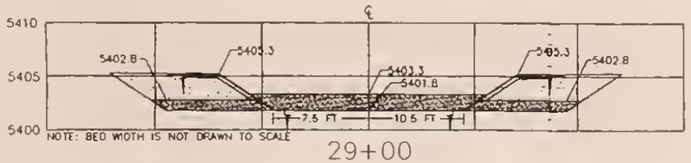


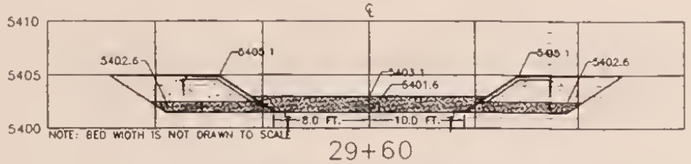
27+00



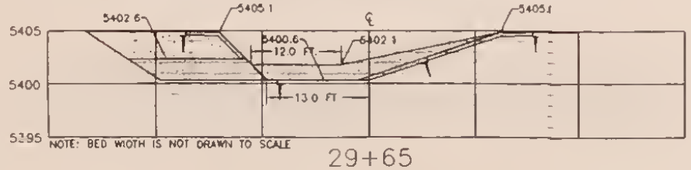
28+00



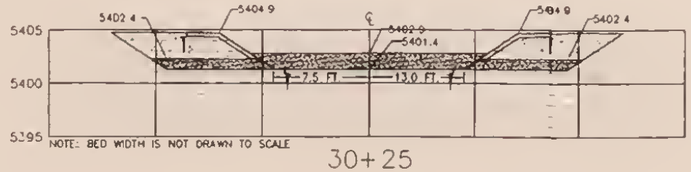
29+00



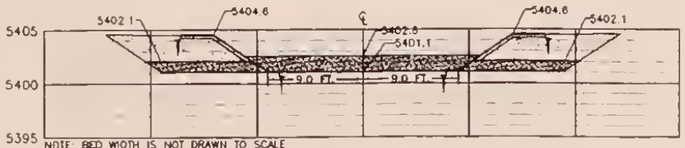
29+60



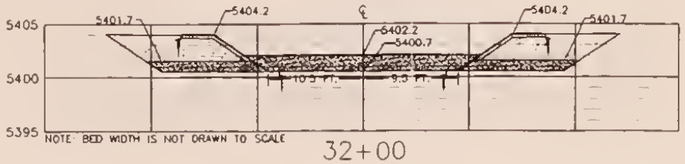
29+65



30+25



31+00



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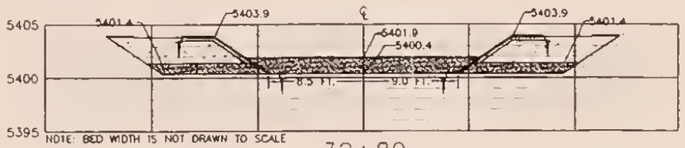
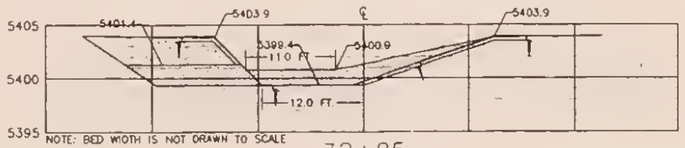
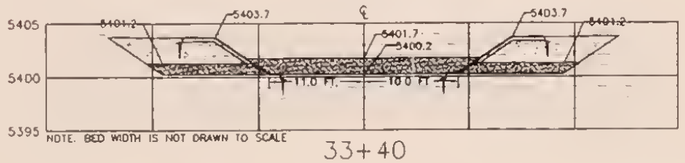


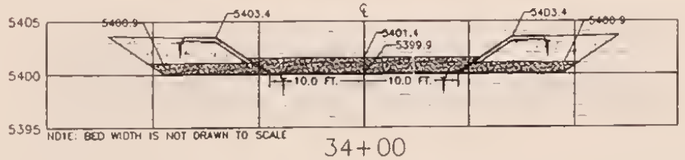
32+80



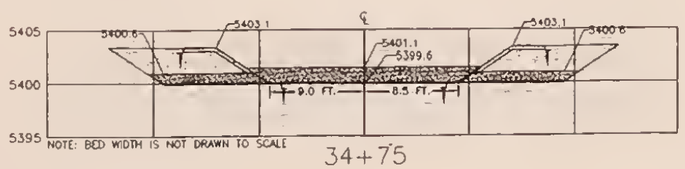
32+85



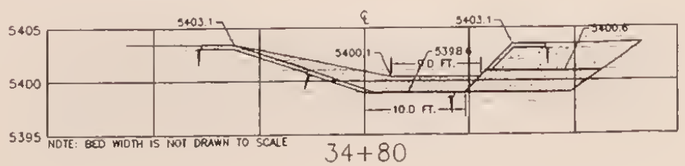
33+40



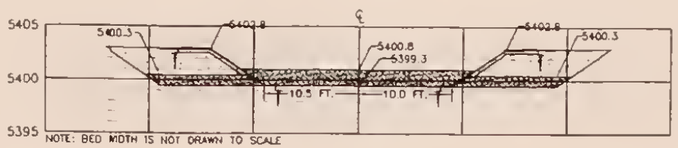
34+00



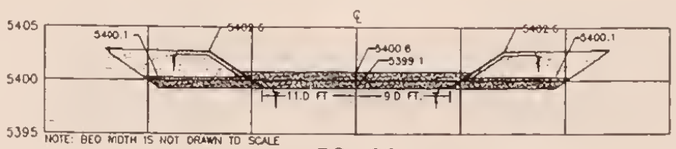
34+75



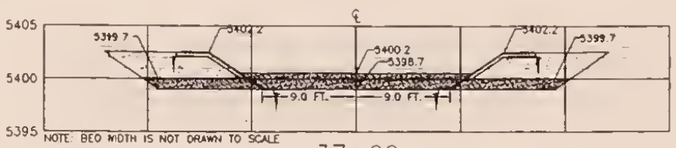
34+80



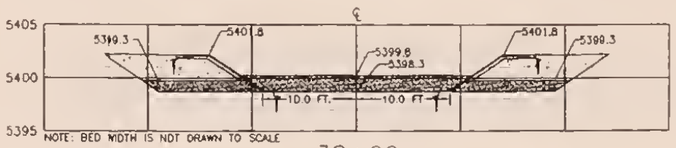
35+50



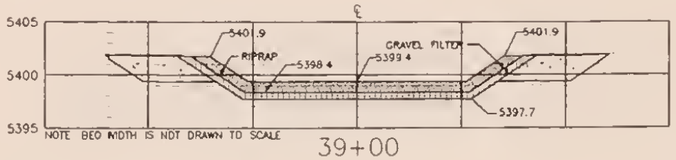
36+00



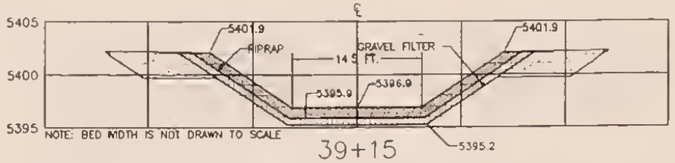
37+00



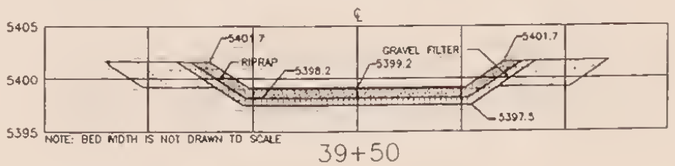
38+00



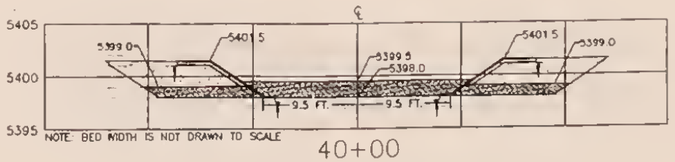
39+00



39+15



39+50



40+00

NOTE: SEE TYPICAL BANK DETAILS OF CROSS-SECTIONS FOR SLOPES (SHEET 112)

RECONSTRUCTION CHANNEL
CROSS SECTIONS
STATIONS 29+00 TO 43+15

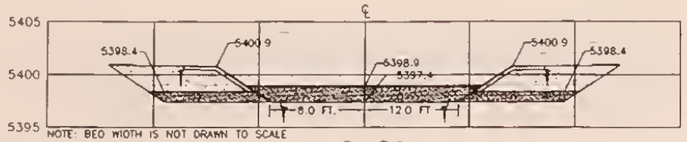
INTER-FLUVE, INC.
BOZEMAN, MONTANA (406) 586-8926 HOOD RIVER, OREGON (541) 308-8005

FINAL DESIGN
STREAMSIDE TAILINGS OPERABLE UNIT
SILVER BOW CREEK-SUBAREA 1-REACH A

DRAWN BY REP DATE 3-2-98
APPROVED BY MAR DATE 06-08-99
DRAWING FILE 19.DWG DATE 06-08-99

SHEET
19 of 127

41+00



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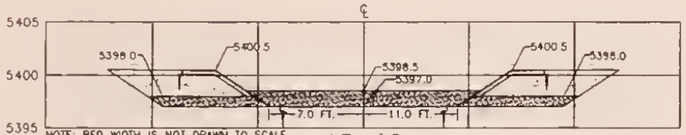

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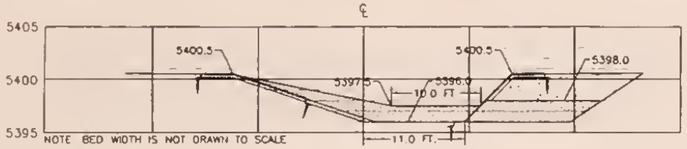

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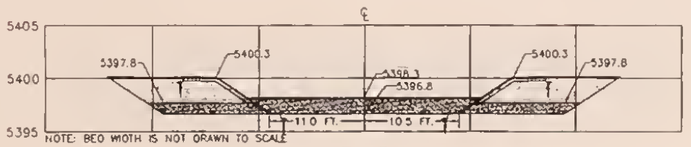

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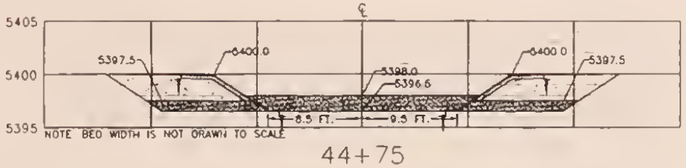

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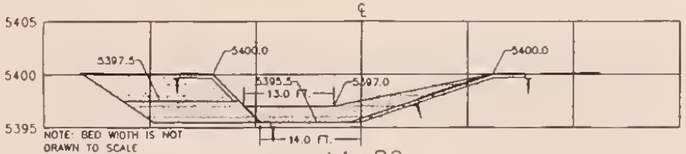

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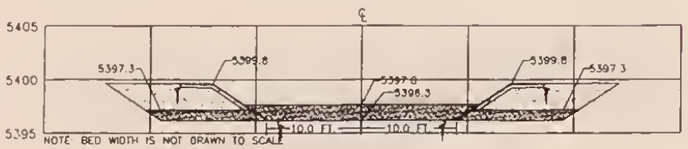

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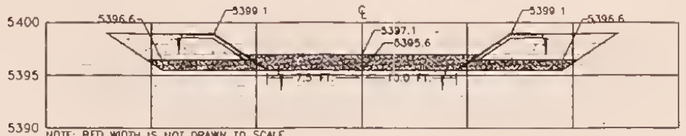

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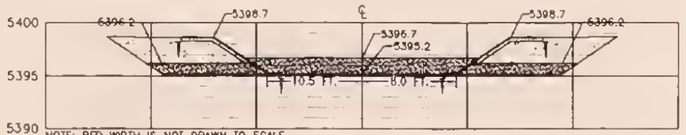

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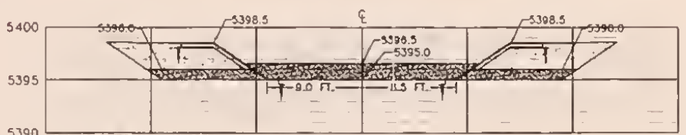

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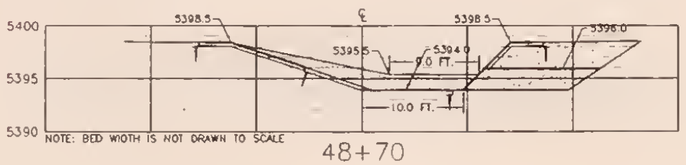

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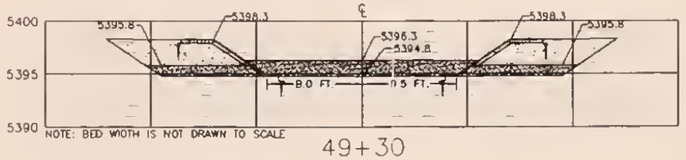

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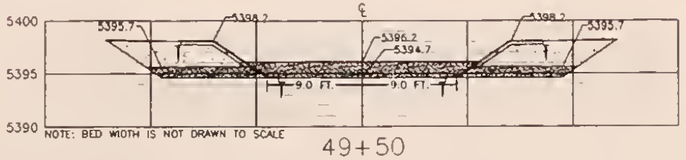

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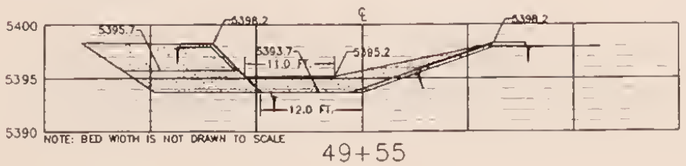

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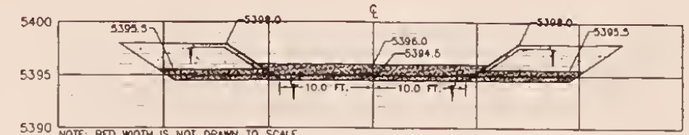

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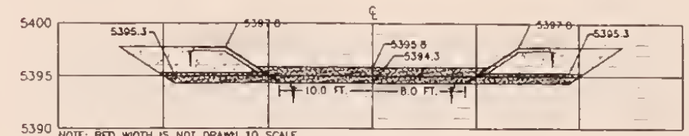

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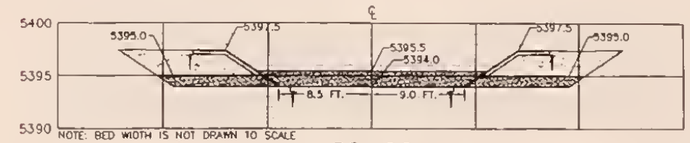

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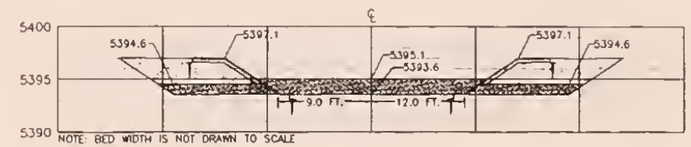

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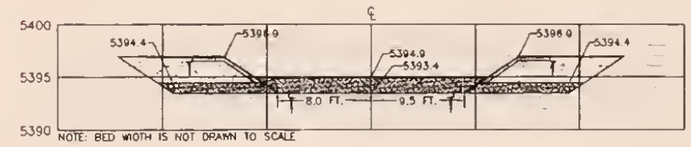

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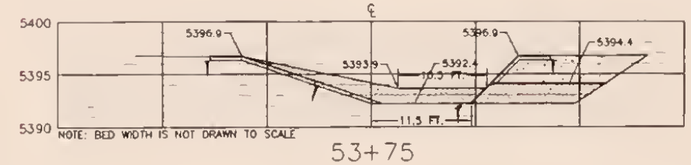

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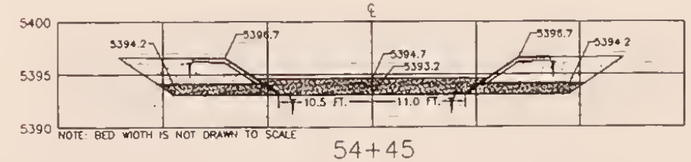

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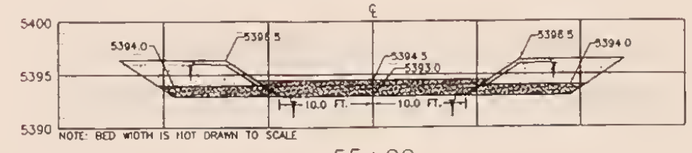


55+00

NOTE: SEE TYPICAL BANK DETAILS OF CROSS-SECTIONS FOR SLOPES (SHEET 112)

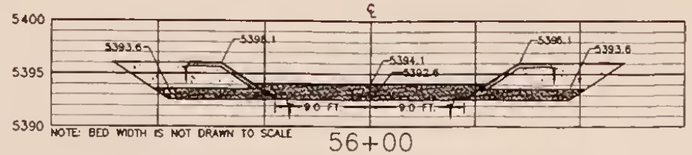
RECONSTRUCTED CHANNEL
CROSS SECTIONS
STATIONS 43+80 TO 57+00

INTER-FLUVE, INC.
BOZEMAN, MONTANA (406) 586-8376 HOOD RIVER, OREGON (541) 386-9003

FINAL DESIGN
STREAMSIDE TAILINGS OPERABLE UNIT
SILVER BOW CREEK-SUBAREA 1-REACH A

DRAWN BY: REP
DATE: 3-2-98
APPROVED BY: MAR
DATE: 06-08-99
DRAWING FILE: 110.DWG
DATE: 06-08-99

SHEET:
110 of 127



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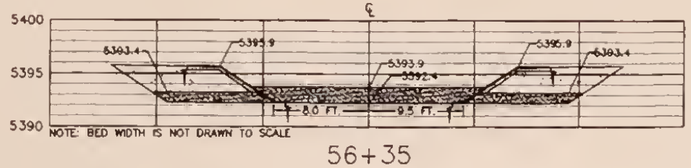

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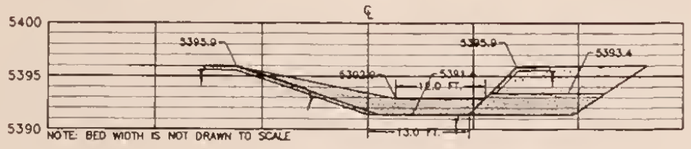

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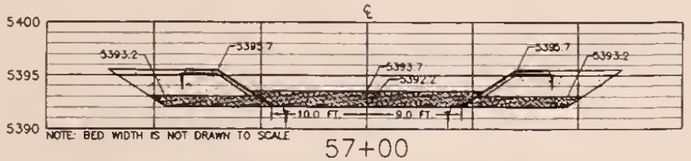

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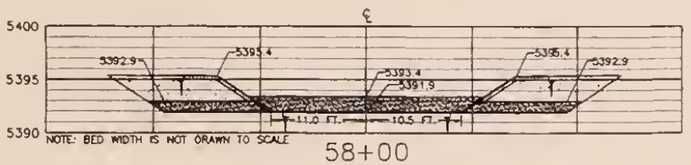

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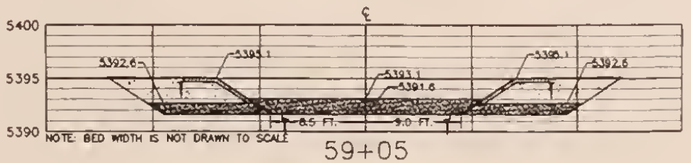

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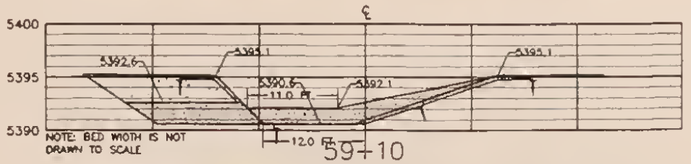

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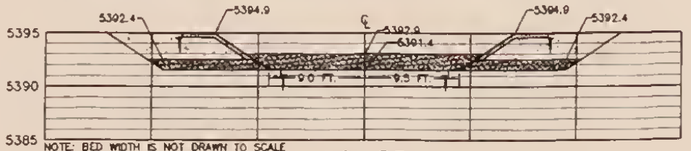

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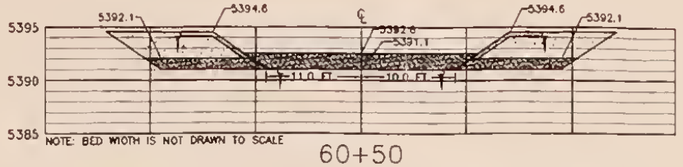

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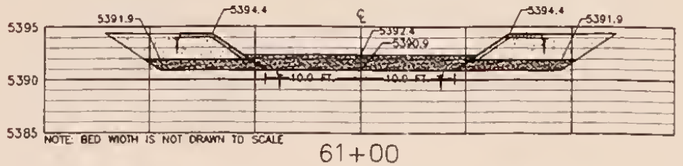

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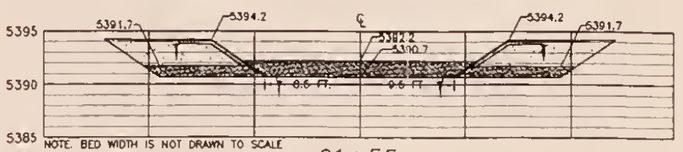

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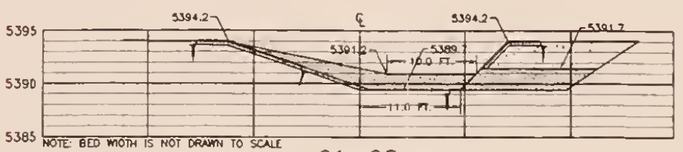

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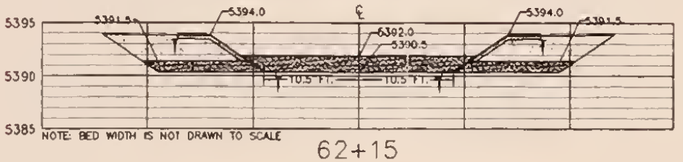

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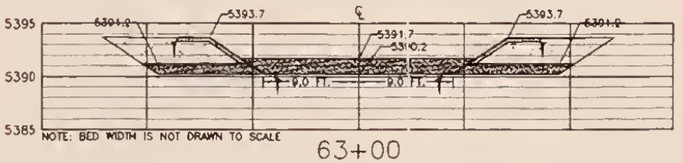

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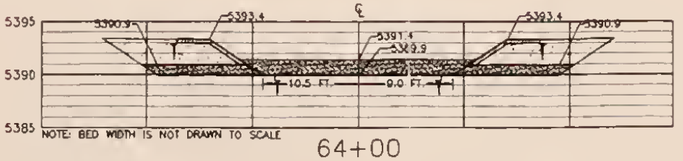

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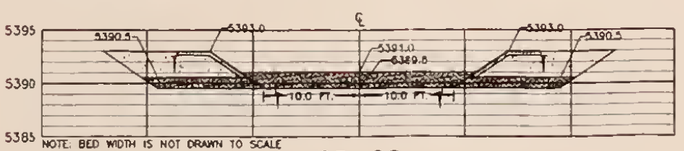

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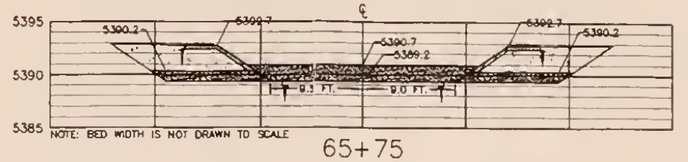

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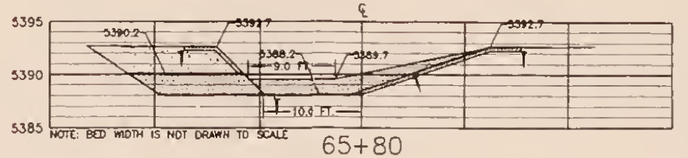

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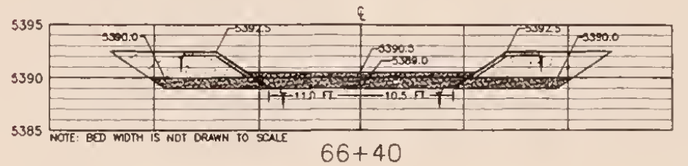

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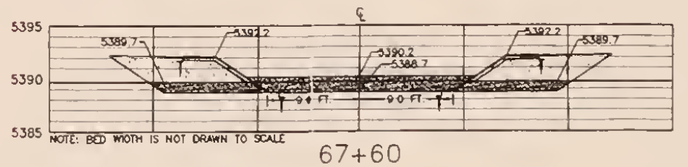
67+00



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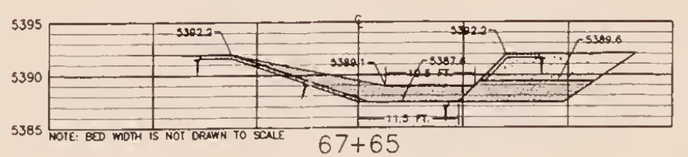

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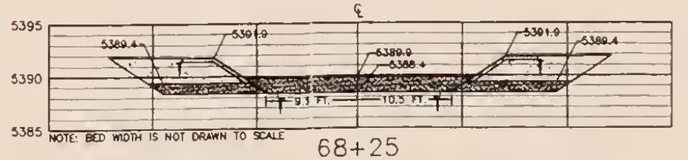


68+25

69+00

NOTE: SEE TYPICAL BANK DETAILS OF CROSS-SECTIONS FOR SLOPES (SHEET 112)

RECONSTRUCTED CHANNEL
CROSS SECTIONS
STATIONS 58+00 TO 69+00

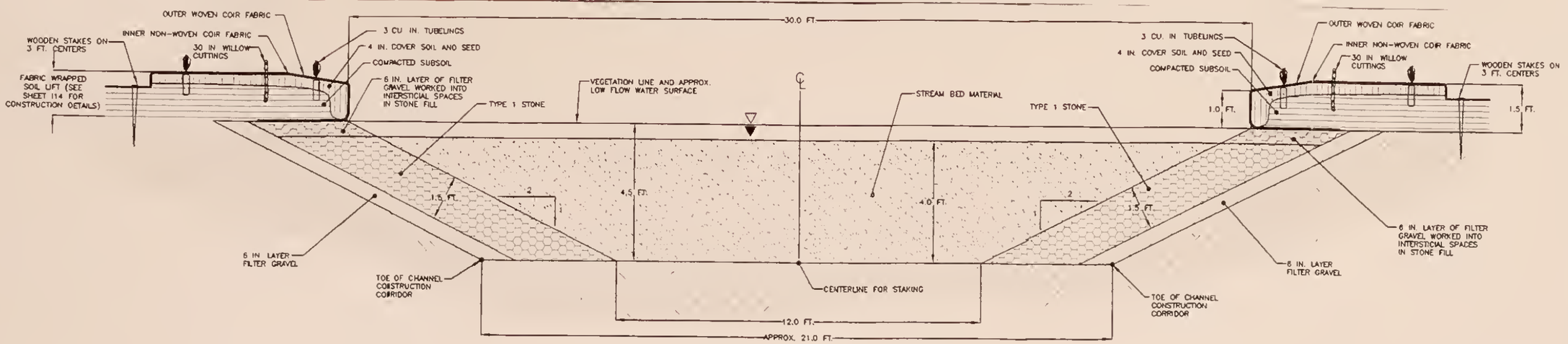
INTER-FLUVE, INC.
BOZEMAN, MONTANA (406) 586-8626 HOOD RIVER, OREGON (541) 386-9003

FINAL DESIGN
STREAMSIDE TAILINGS OPERABLE UNIT
SILVER BOW CREEK-SUBAREA 1-REACH A

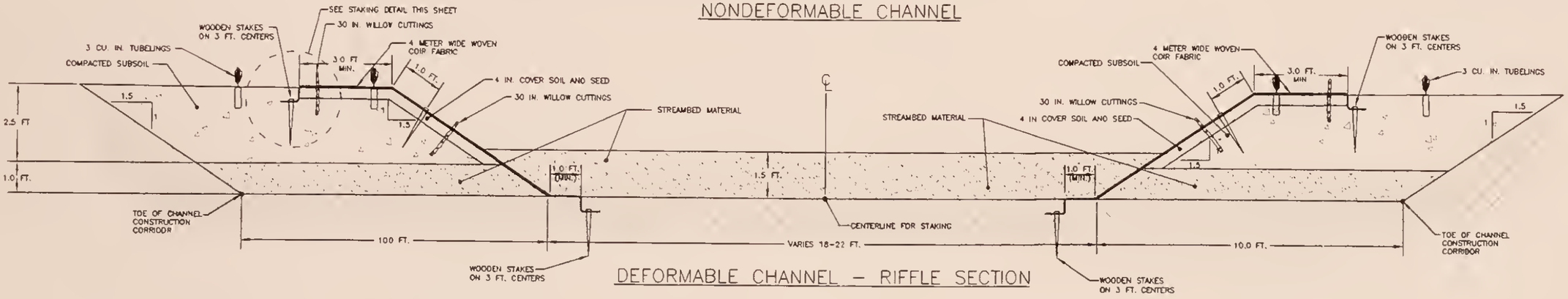
BY/DATE	REVISION

DRAWN BY: REP
DATE: 3-2-98
APPROVED BY: MAR
DATE: 06-08-99
DRAWING FILE: I11.DWG
DATE: 06-08-99

SHEET:
111 of 127


OUTER WOVEN COIR FABRIC
INNER NON-WOVEN COIR FABRIC
WOODEN STAKES ON 3 FT. CENTERS
30 IN. WILLOW CUTTINGS
3 CU. IN. TUBELINGS
4 IN. COVER SOIL AND SEED
COMPACTED SUBSOIL
6 IN. LAYER OF FILTER GRAVEL WORKED INTO INTERSTICIAL SPACES IN STONE FILL
FABRIC WRAPPED SOIL LIFT (SEE SHEET 114 FOR CONSTRUCTION DETAILS)
TYPE 1 STONE
VEGETATION LINE AND APPROX. LOW FLOW WATER SURFACE
30.0 FT.
STREAM BED MATERIAL
1.5 FT.
2
1
4.5 FT.
4.0 FT.
6 IN. LAYER FILTER GRAVEL
TOE OF CHANNEL CONSTRUCTION CORRIDOR
CENTERLINE FOR STAKING
12.0 FT.
APPROX. 21.0 FT.
1.0 FT.
1.5 FT.

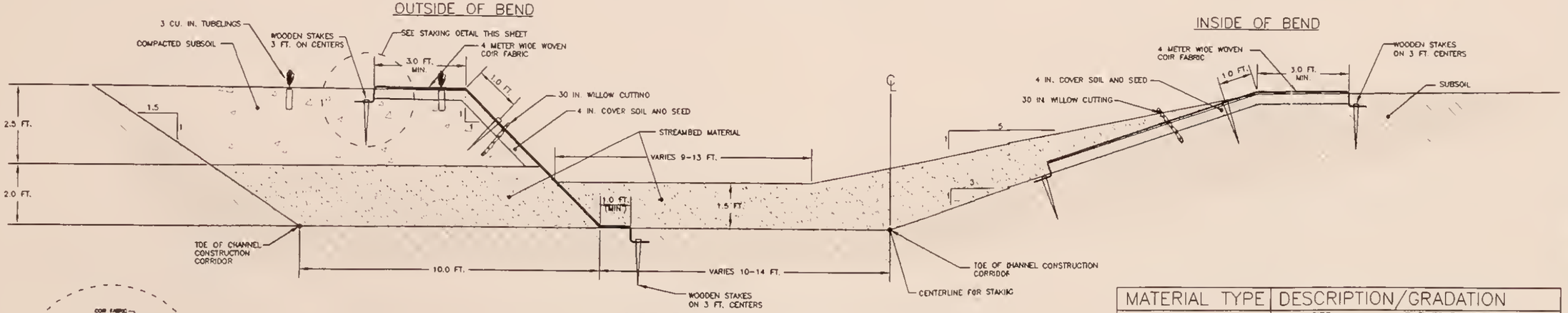
NONDEFORMABLE CHANNEL



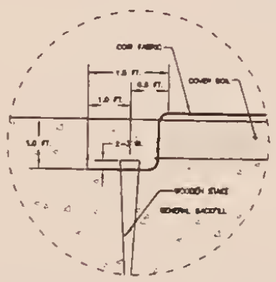
DEFORMABLE CHANNEL – RIFFLE SECTION

OUTSIDE OF BEND

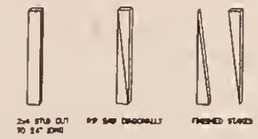
INSIDE OF BEND



DEFORMABLE CHANNEL – POOL SECTION



KEY TRENCH STAKING DETAIL



STAKE FABRICATING DETAILS

NOTE:
WILLOW CUTTINGS AND TUBELINGS ARE NOT PART OF THIS CONTRACT. PLANTING WILL OCCUR UNDER A SEPARATE REVEGETATION CONTRACT. THEY ARE SHOWN HERE FOR COMPLETENESS ONLY.

MATERIAL TYPE	DESCRIPTION/GRADATION	
	SIZE	% FINER BY WEIGHT
STREAMBED MATERIAL	3.5 IN.	100
	2.0 IN.	70–90
	1.5 IN.	40–60
	1.0 IN.	15–30
	0.75 IN.	0–10
COIR FABRIC	700 SERIES (700 GRAMS/METER) CONTINUOUSLY WOVEN MAT OF HIGH STRENGTH COIR (100% COCONUT FIBER)	
* WILLOW CUTTINGS	DORMANT, UNROOTED WILLOW STEMS 30 IN. IN LENGTH	
* TUBELINGS	NURSERY-GROWN, ROOTED HERBACEOUS PLANTS GROWN IN TUBE SHAPED, 3 CUBIC IN. CONTAINERS	

* SEE NOTE TO LEFT

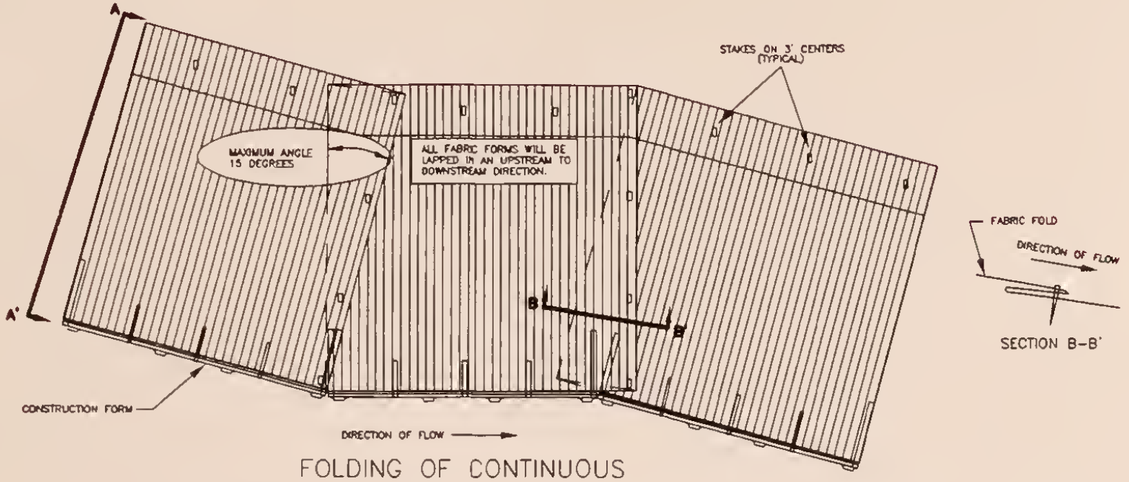
TYPICAL BANK TREATMENT DETAILS

INTER-FLUVE, INC.
BOZEMAN, MONTANA (406) 586-6578 HOOD RIVER, OREGON (541) 386-9003

FINAL DESIGN
STREAMSIDE TAILINGS OPERABLE UNIT
SILVER BOW CREEK–SUBAREA 1–REACH A

DRAWN BY: REP	
DATE: 3-2-98	
APPROVED BY: MAR	
DATE: 11-30-98	
DRAWING FILE: 112.DWG	
DATE: 11-30-98	

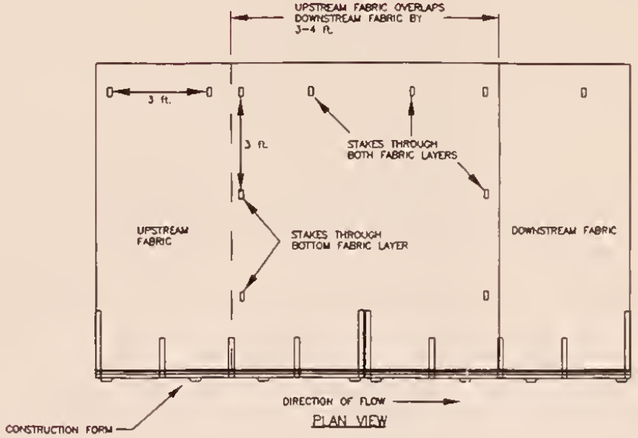
SHEET
112 of 127



SECTION B-B'

FOLDING OF CONTINUOUS SHEET FABRIC AT BENDS

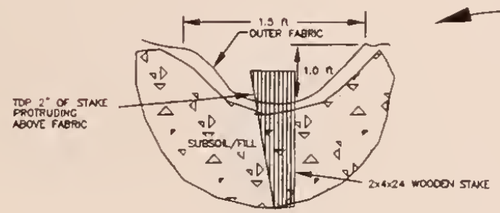
PLAN VIEW



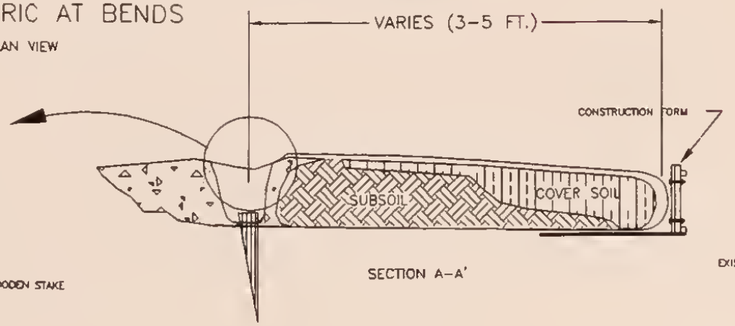
PLAN VIEW

FABRIC JOINING DETAIL- JOINING ENDS OF WOVEN COIR FABRIC ROLLS ON FABRIC WRAPPED LIFTS AND NON-WOVEN COIR ROLLS ON FLOODPLAIN SURFACE

NOT TO SCALE

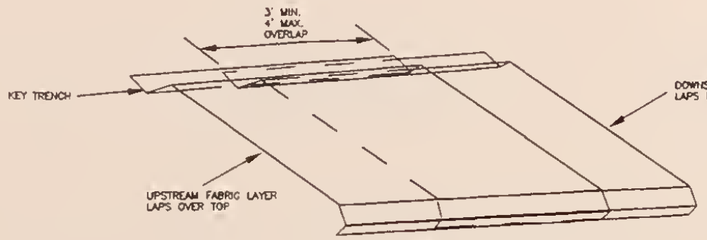


DETAIL OF KEY TRENCH

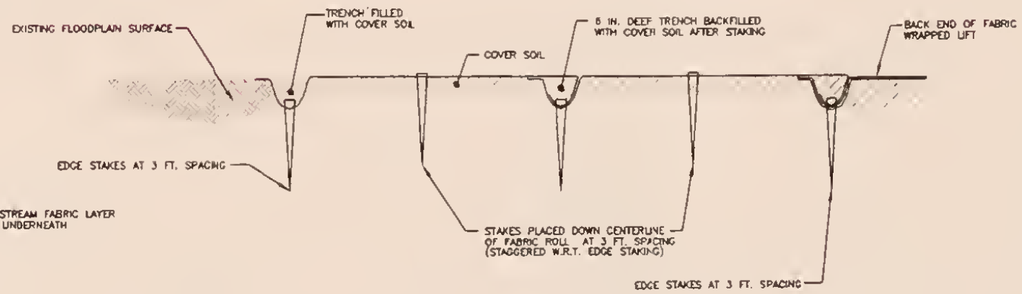


SECTION A-A'

STAKE FABRICATING DETAILS



ISOMETRIC


EXISTING FLOODPLAIN SURFACE
TRENCH FILLED WITH COVER SOIL
COVER SOIL
6 IN. DEEP TRENCH BACKFILLED WITH COVER SOIL AFTER STAKING
BACK END OF FABRIC WRAPPED LIFT
EDGE STAKES AT 3 FT. SPACING
STAKES PLACED DOWN CENTERLINE OF FABRIC ROLL AT 3 FT. SPACING (STAGGERED W.R.T. EDGE STAKING)
EDGE STAKES AT 3 FT. SPACING

STAKING DETAIL FOR NON-WOVEN COIR FABRIC ON FLOODPLAIN SURFACE

NOT TO SCALE

GENERAL NOTES ON SECURING FABRIC ON STREAMBANK LIFT

1. FABRICATE THE WOODEN STAKES BY CUTTING 2x4 STUDS INTO 2 FOOT LENGTHS AND THEN RIPPING THE LENGTHS DIAGONALLY TO CREATE A TAPERED END. SEE STAKE FABRICATION DETAIL ON THIS SHEET.
2. FORMS MAY BE ANGLED TO CREATE BENDS IN THE LIFTS AS NEEDED. FABRIC SHALL BE FOLDED AT EACH BEND AS SHOWN IN PLAN VIEW. NO BEND SHALL EXCEED A 15 DEGREE ANGLE. FOLDS SHALL BE MADE IN AN UPSTREAM TO DOWNSTREAM DIRECTION. STAKE THE FOLDS AS SHOWN IN SECTION B-B'.
3. OUTER FABRIC ENDS SHALL BE JOINED BY LAPPING THE UPSTREAM PIECE OF FABRIC OVER THE DOWNSTREAM PIECE AS SHOWN IN PLAN VIEW. OVERLAPS SHALL BE A MINIMUM OF 3 FEET. INNER FABRIC ENDS SHALL BE BUTTED TOGETHER, NOT OVERLAPPED. OVERLAPS SHALL BE STAGGERED FROM LIFT TO LIFT BY A MINIMUM OF 15 FT.
4. SECURE THE BANK SIDE EDGE OF THE OUTER FABRIC (WOVEN), WITH A WOODEN STAKE THROUGH THE FABRIC ON 3 FOOT CENTERS (SEE PLAN VIEWS). NOTE: THE HOLES FOR STAKES SHALL NOT BE PRECUT. ALLOW THE STAKE TO BREAK THE MINIMUM NUMBER OF STRANDS AS IT IS BEING DRIVEN. DRIVE STAKES SO THAT A MAXIMUM OF 2" IS LEFT EXPOSED.

COIR FABRIC INSTALLATION

INTER-FLUVE, INC.
BOZEMAN, MONTANA (406) 586-0503 1000 RIVER, OREGON (541) 385-7003

FINAL DESIGN
STREAMSIDE TAILINGS OPERABLE UNIT
SILVER BOW CREEK-SUBAREA 1-REACH A

DESIGNED BY:	
DRAWN BY: REP	
CHECKED BY:	
APPROVED BY: MAR	
DATE: 3-2-98	DATE: 11-30-98
	DRAWING FILE: 113.DWG
	DATE: 11-30-98

SHEET:

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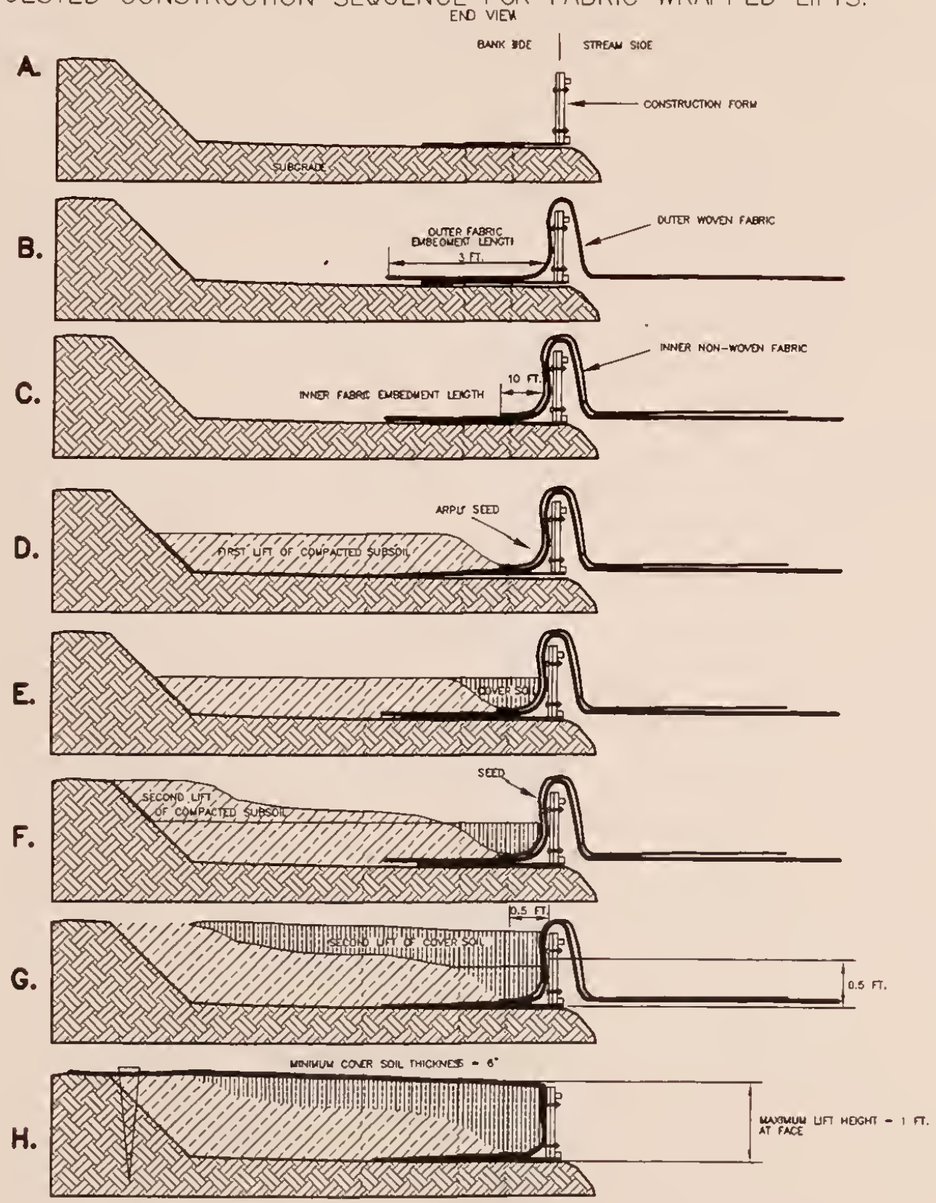
SUGGESTED CONSTRUCTION SEQUENCE FOR FABRIC WRAPPED LIFTS.



GENERAL INSTRUCTIONS FOR CONSTRUCTING FABRIC WRAPPED LIFTS.

1. BANKS MAY BE CONSTRUCTED IN EITHER AN UPSTREAM OR DOWNSTREAM DIRECTION, AS LONG AS THE FABRIC IS OVERLAPPED IN THE PROPER DIRECTION.
2. PLACE A SERIES OF THREE OR MORE FORMS ON THE GROUND SO THAT THE FORMS FOLLOW THE PROPOSED STREAM BANK ALIGNMENT. BUTT THE ENDS OF THE FORMS TIGHTLY TOGETHER
3. UNROLL THE OUTER FABRIC (WOVEN COIR) PARALLEL TO THE LONG AXIS OF THE CHANNEL AND POSITION IT SO THAT 3 FEET EXTENDS FOR EMBEDMENT ON THE BANK SIDE OF THE FORMS (FIG B), AND A MINIMUM 3 FEET EXTENDS LENGTHWISE BEYOND THE LAST FORM FOR OVERLAP. DRAPE THE REMAINDER OF THE FABRIC OVER THE TOP OF THE FORMS ON THE STREAM SIDE (FIG B).
4. UNROLL THE INNER FABRIC (NON-WOVEN COIR) OVER THE TOP OF THE OUTER FABRIC AND POSITION IT SO THAT AT LEAST 1 FOOT OF THE INNER FABRIC EXTENDS AS AN EMBEDMENT LENGTH ON THE BANK SIDE OF THE FORMS (FIG C). DRAPE THE REMAINDER OF THE FABRIC OVER THE TOP OF THE FORMS ON THE STREAM SIDE AND ALIGN THE LONG EDGES OF THE INNER AND OUTER FABRICS. STRETCH AND PULL THE FABRIC LAYERS TO REMOVE WRINKLES.
5. PLACE SUBSOIL OVER THE FABRIC ON THE BANK SIDE OF THE FORMS TO A DEPTH OF APPROXIMATELY 8 INCHES THEN COMPACT. LEAVE A 1.5 FOOT WIDE AREA FOR PLACING COVER SOIL NEXT TO THE FORM (FIG D). FILL THIS AREA WITH 8" OF COVER SOIL. LEVEL THE FILL AND COMPACT TO 85-90 PERCENT (FIG E).
6. PLACE ADDITIONAL LAYERS OF SUBSOIL TO FORM THE LIFT AS SHOWN (FIG F). ADD COVER SOIL TO CREATE A COMPACTED LAYER 4" DEEP OVER THE SUBSOIL (FIG G).
7. FOLD THE LOOSE ENDS OF THE TWO FABRIC LAYERS BACK OVER THE COMPACTED FILL MATERIAL AND STRETCH TIGHTLY TO REMOVE WRINKLES (FIG H). SECURE WITH WOODEN STAKES.
8. EXCAVATE A KEY TRENCH 1.5 FEET WIDE AND .5 FEET DEEP ALONG THE EDGE OF THE OUTER FABRIC LAYER, PARALLEL TO THE FORMS. SECURE FABRIC IN THE KEY TRENCH WITH WOODEN STAKES.
9. BACKFILL & COMPACT THE KEY TRENCH WITH COVER SOIL AND CONTINUE TO APPLY COVER SOIL TO SMOOTHLY MERGE WITH EXISTING CONTOURS.

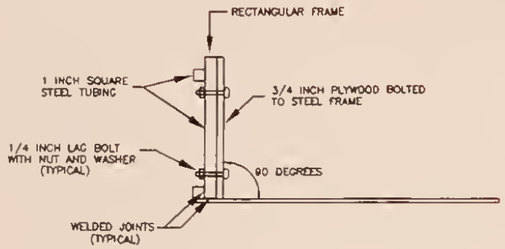
FABRIC WRAPPED LIFT ASSEMBLY

INTER-FLUVE, INC.
BOZEMAN, MONTANA (406) 586-0375 HOOD RIVER, OREGON (541) 386-9003

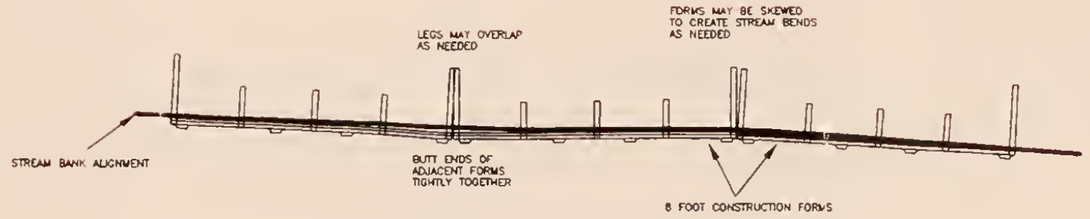
FINAL DESIGN
STREAMSIDE TAILINGS OPERABLE UNIT
SILVER BOW CREEK-SUBAREA 1-REACH A

DRAWN BY: REP	
DATE: 3-2-98	
APPROVED BY: MAR	
DATE: 11-30-98	
DRAWING FILE: 114.DWG	
DATE: 11-30-98	

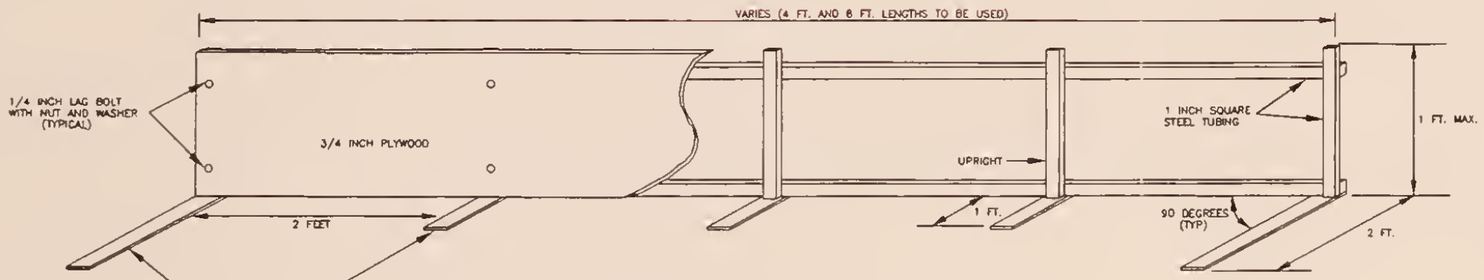
SHEET:
114 of 127


RECTANGULAR FRAME
1 INCH SQUARE STEEL TUBING
3/4 INCH PLYWOOD BOLTED TO STEEL FRAME
1/4 INCH LAG BOLT WITH NUT AND WASHER (TYPICAL)
90 DEGREES
WELDED JOINTS (TYPICAL)

STREAM BANK CONSTRUCTION FORM
END VIEW


FORMS MAY BE SKEWED TO CREATE STREAM BENDS AS NEEDED
LEGS MAY OVERLAP AS NEEDED
STREAM BANK ALIGNMENT
BUTT ENDS OF ADJACENT FORMS TIGHTLY TOGETHER
8 FOOT CONSTRUCTION FORMS

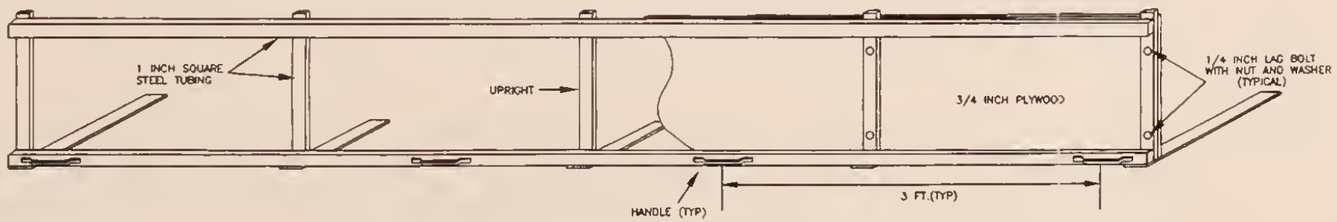
STREAM BANK CONSTRUCTION FORM
SUGGESTED PLACEMENT
PLAN VIEW


VARIES (4 FT. AND 8 FT. LENGTHS TO BE USED)
1/4 INCH LAG BOLT WITH NUT AND WASHER (TYPICAL)
3/4 INCH PLYWOOD
UPRIGHT
1 INCH SQUARE STEEL TUBING
1 FT. MAX.
2 FEET
1 FT.
90 DEGREES (TYP)
2 FT.
1/4 x 2 INCH STRAP STEEL LEGS

STREAM BANK CONSTRUCTION FORM
ISOMETRIC VIEW FROM REAR

GENERAL NOTES ON FABRICATION OF FORMS FOR FABRIC WRAPPED LIFT CONSTRUCTION

1. CONTRACTOR RESPONSIBLE FOR MODIFYING FORM LENGTHS TO FIT STREAM BENDS (1/2 OF THE FORMS WILL BE MODIFIED TO 4 FT. LENGTHS).



STREAM BANK CONSTRUCTION FORM
ISOMETRIC VIEW FROM FRONT

FABRIC WRAPPED LIFT
CONSTRUCTION FORMS

INTER-FLUVE, INC.
BOZEMAN, MONTANA (406) 586-0533

FINAL DESIGN
STREAMSIDE TAILINGS OPERABLE UNIT
SILVER BOW CREEK-SUBAREA 1-REACH A

BY/DATE	REVISION FOR

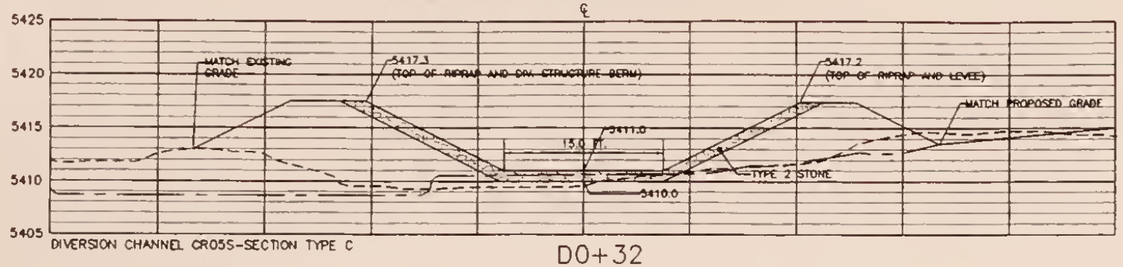
DRAWN BY: REP
DATE: 3-2-98
APPROVED BY: MAR
DATE: 11-30-98
DRAWING FILE: 115.DWG
DATE: 11-30-98

SHEET:
115 of 127

PROPOSED GRADE

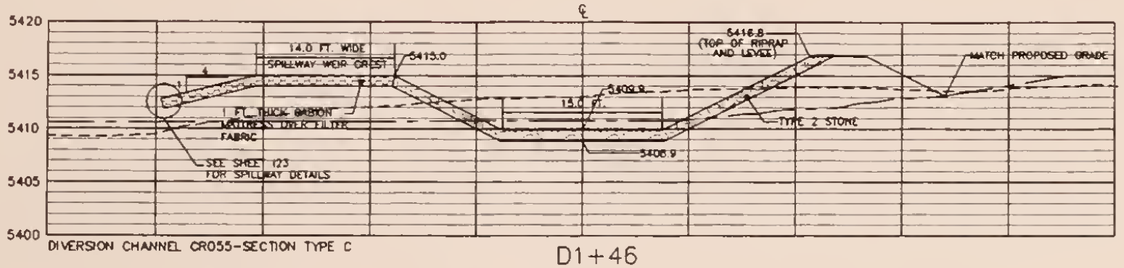
EXISTING GRADE

NOTE:
SOME SEGMENTS OF PROPOSED GRADE WILL NOT BE CONSTRUCTED UNTIL AFTER REMOVAL OF THE DIVERSION CHANNEL. PROPOSED GRADE IS SHOWN ON THE CROSS-SECTIONS FOR PURPOSES OF TIEING-IN TO THE DIVERSION CHANNEL, WHERE APPLICABLE, AND FOR FUTURE CONSTRUCTION REFERENCE.



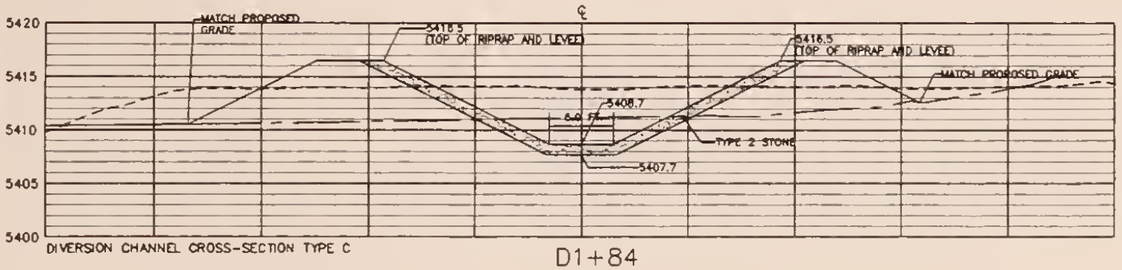
DIVERSION CHANNEL CROSS-SECTION TYPE C

D0+32



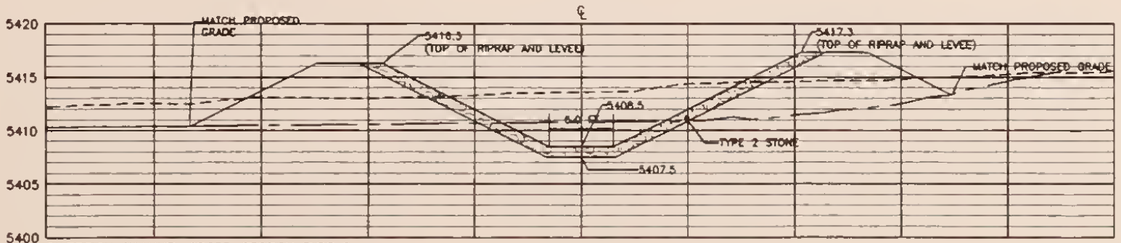
DIVERSION CHANNEL CROSS-SECTION TYPE C

D1+46



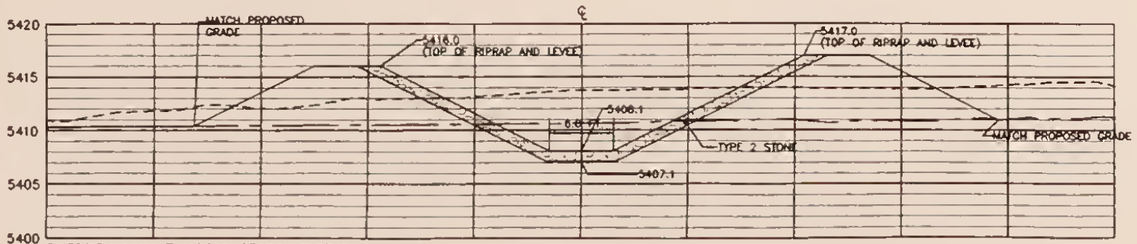
DIVERSION CHANNEL CROSS-SECTION TYPE C

D1+84



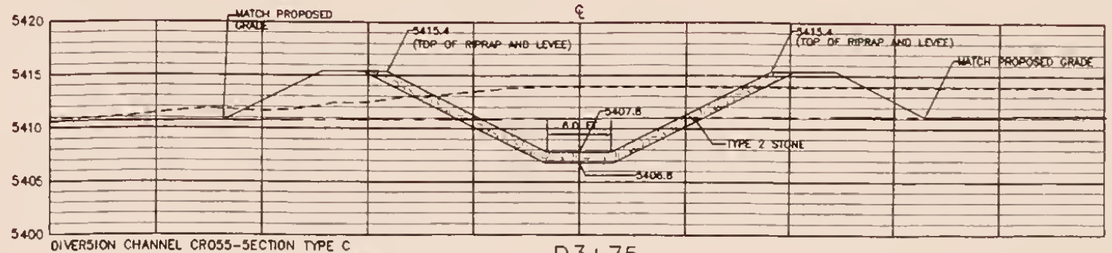
DIVERSION CHANNEL CROSS-SECTION TYPE C

D2+36



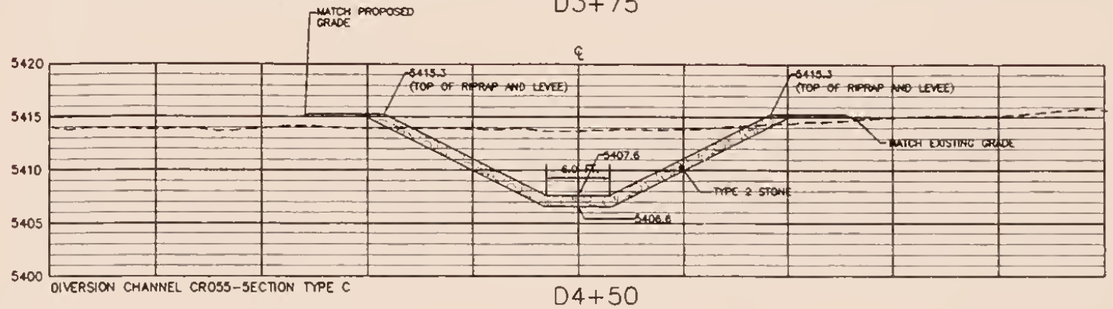
DIVERSION CHANNEL CROSS-SECTION TYPE C

D3+00



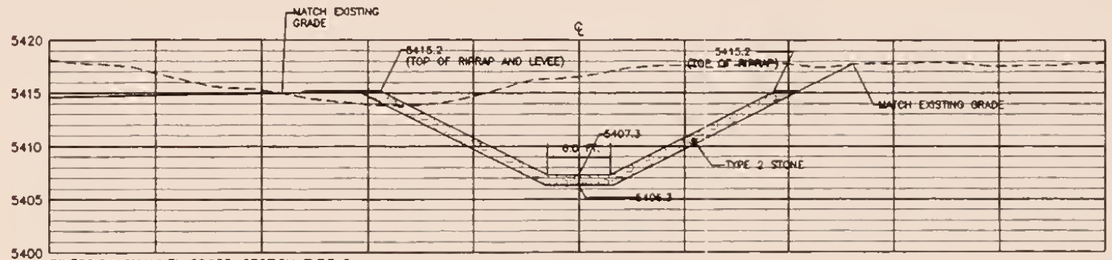
DIVERSION CHANNEL CROSS-SECTION TYPE C

D3+75



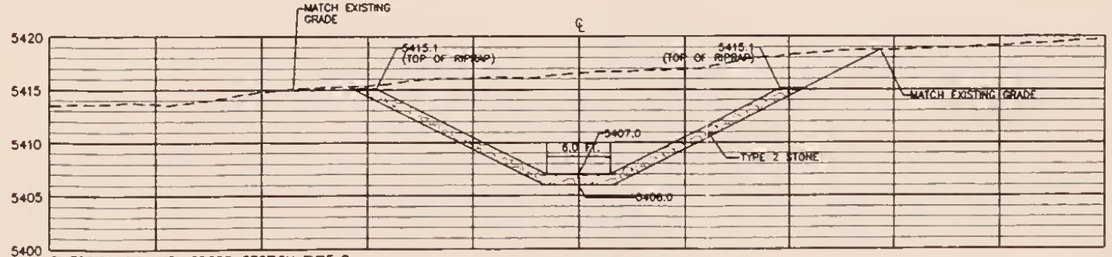
DIVERSION CHANNEL CROSS-SECTION TYPE C

D4+50



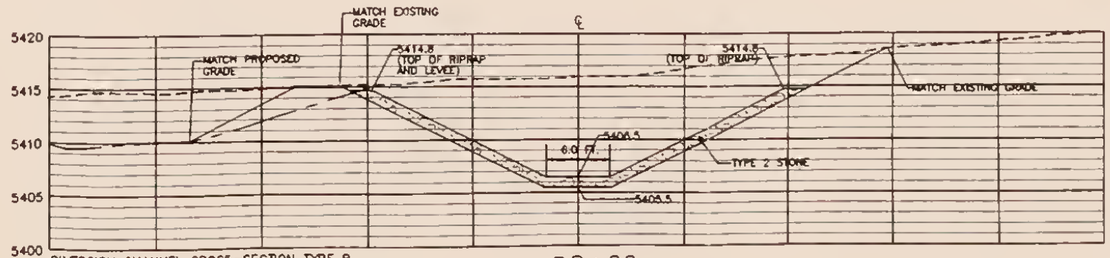
DIVERSION CHANNEL CROSS-SECTION TYPE C

D5+25



DIVERSION CHANNEL CROSS-SECTION TYPE B

D6+00



DIVERSION CHANNEL CROSS-SECTION TYPE B

D8+00

DIVERSION CHANNEL CROSS-SECTIONS
STA. D0+32 TO D8+00

INTER-FLUVE, INC.
BOZEMAN, MONTANA (406) 586-0277 HOOD RIVER, OREGON (541) 386-9003

FINAL DESIGN
STREAMSIDE TAILINGS OPERABLE UNIT
SILVER BOW CREEK-SUBAREA 1-REACH A

DESIGNED BY:	
DRAWN BY: EJV	DATE: 3-2-98
APPROVED BY: MAR	DATE: 06-07-99
DRAWING FILE: 116.DWG	DATE: 06-07-99

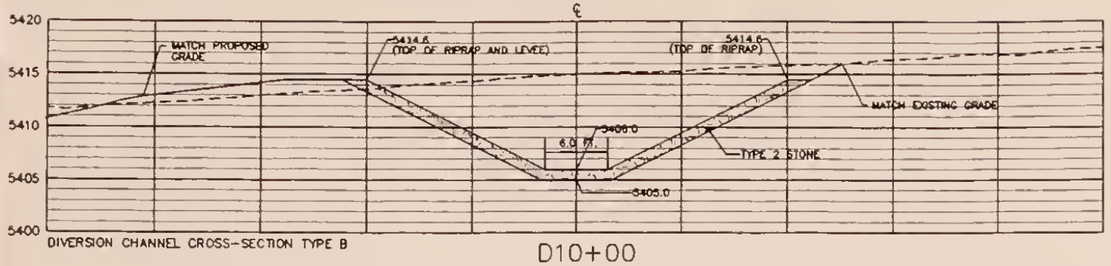
SHEET:

116 of 127

PROPOSED GRADE

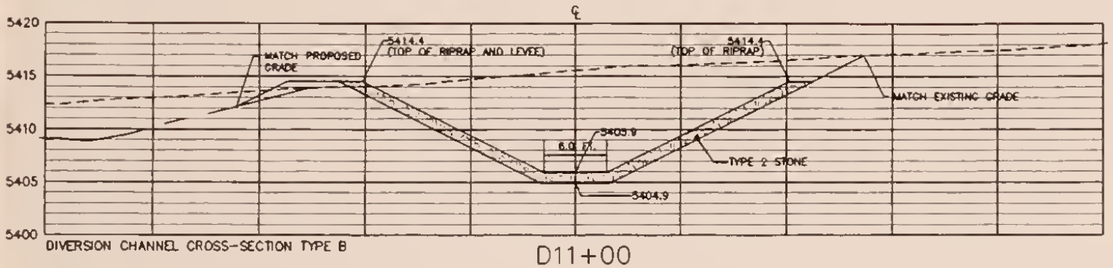
EXISTING GRADE

NOTE:
SOME SEGMENTS OF PROPOSED GRADE WILL NOT BE CONSTRUCTED UNTIL AFTER REMOVAL OF THE DIVERSION CHANNEL. PROPOSED GRADE IS SHOWN ON THE CROSS-SECTIONS FOR PURPOSES OF TRENG-IN TO THE DIVERSION CHANNEL WHERE APPLICABLE, AND FOR FUTURE CONSTRUCTION REFERENCE.



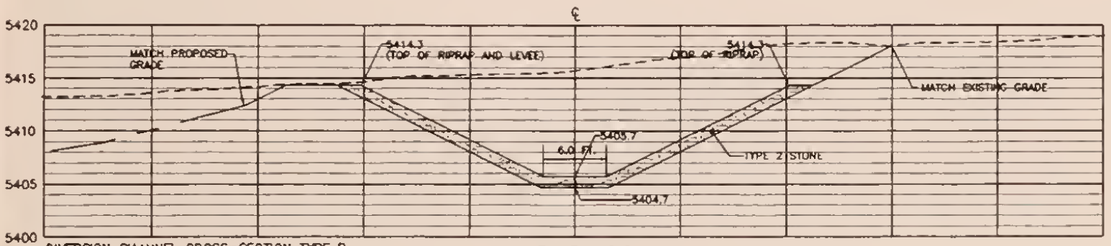
DIVERSION CHANNEL CROSS-SECTION TYPE B

D10+00



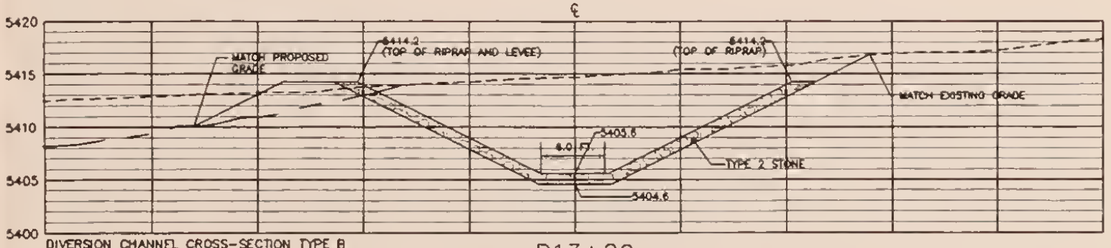
DIVERSION CHANNEL CROSS-SECTION TYPE B

D11+00



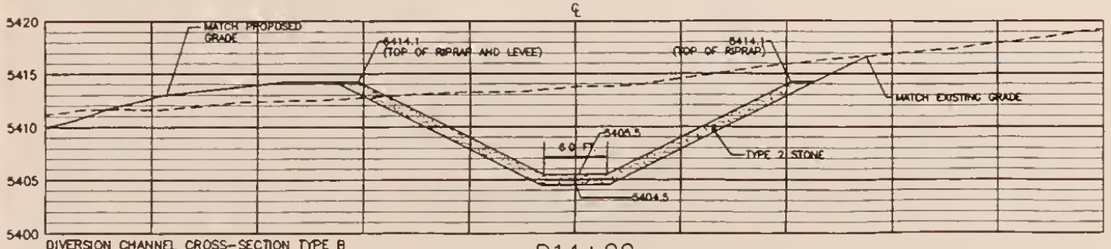
DIVERSION CHANNEL CROSS-SECTION TYPE B

D12+00



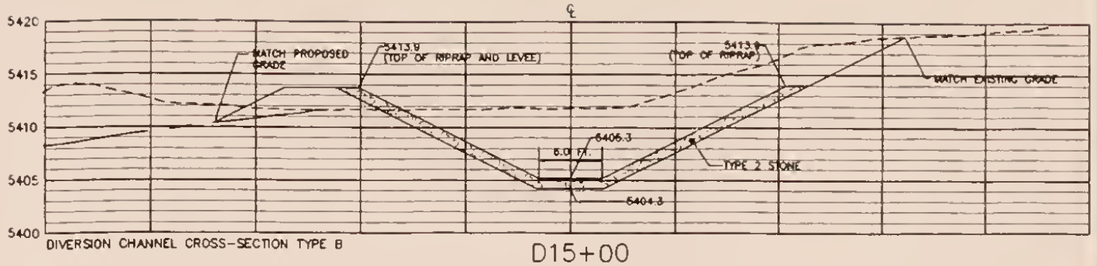
DIVERSION CHANNEL CROSS-SECTION TYPE B

D13+00



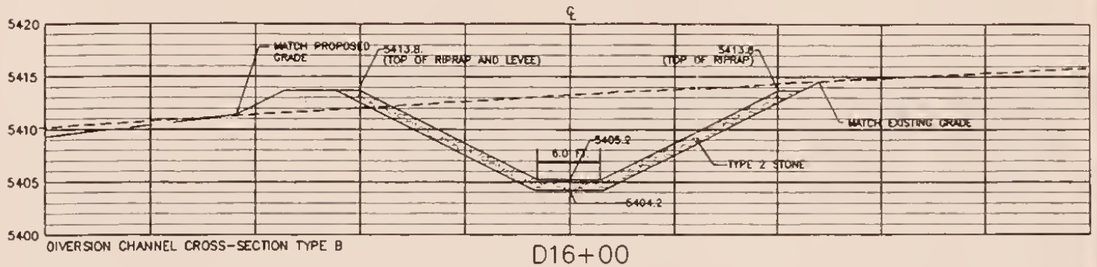
DIVERSION CHANNEL CROSS-SECTION TYPE B

D14+00



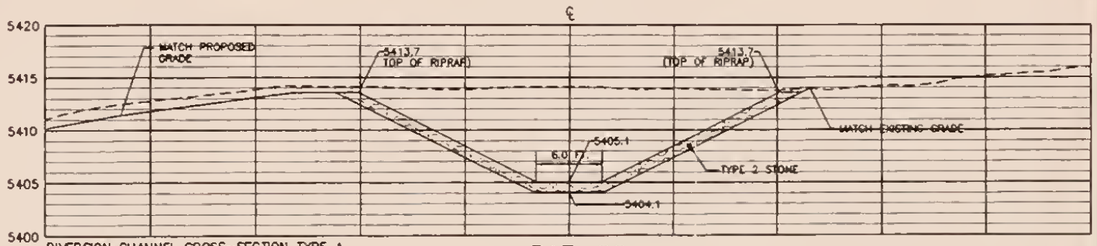
DIVERSION CHANNEL CROSS-SECTION TYPE B

D15+00



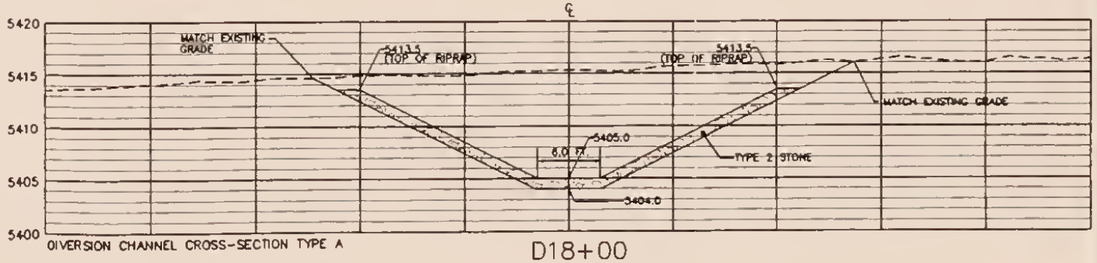
DIVERSION CHANNEL CROSS-SECTION TYPE B

D16+00



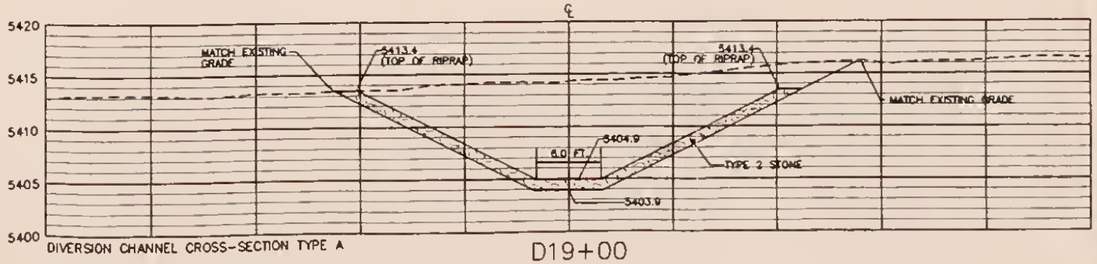
DIVERSION CHANNEL CROSS-SECTION TYPE A

D17+00



DIVERSION CHANNEL CROSS-SECTION TYPE A

D18+00



DIVERSION CHANNEL CROSS-SECTION TYPE A

D19+00

DIVERSION CHANNEL CROSS-SECTIONS
STA. D10+00 TO D19+00

INTER-FLUVE, INC.

FINAL DESIGN
STREAMSIDE TAILINGS OPERABLE UNIT
SILVER BOW CREEK-SUBAREA 1-REACH A

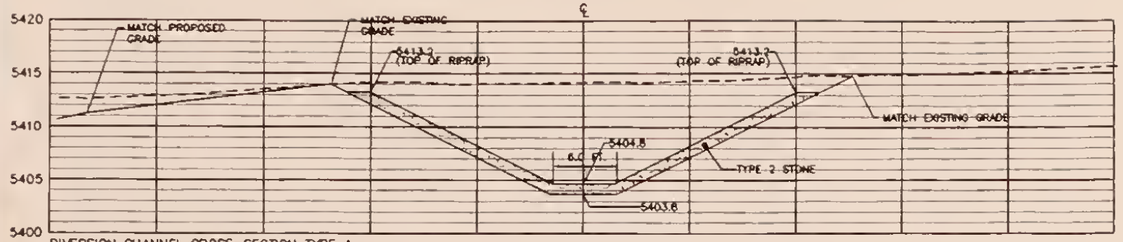
BY EJV 3-2-98
BY MAG 06-07-99
FILE 117.DWG 06-07-99

SHEET:
117 of 127

PROPOSED GRADE

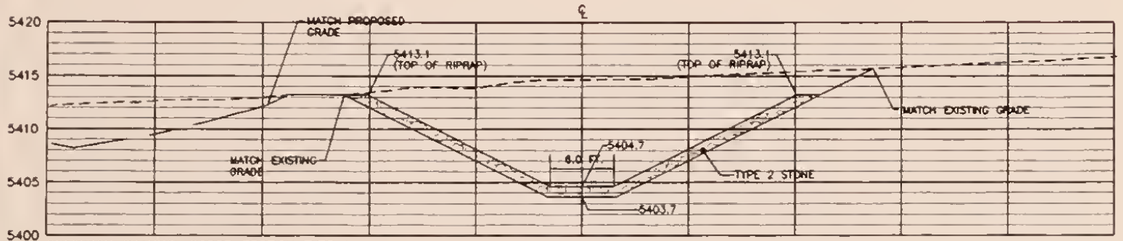
EXISTING GRADE

NOTE:
SOME SEGMENTS OF PROPOSED GRADE WILL NOT BE CONSTRUCTED UNTIL AFTER REMOVAL OF THE DIVERSION CHANNEL. PROPOSED GRADE IS SHOWN ON THE CROSS-SECTIONS FOR PURPOSES OF TIEING-IN TO THE DIVERSION CHANNEL WHERE APPLICABLE, AND FOR FUTURE CONSTRUCTION REFERENCE.



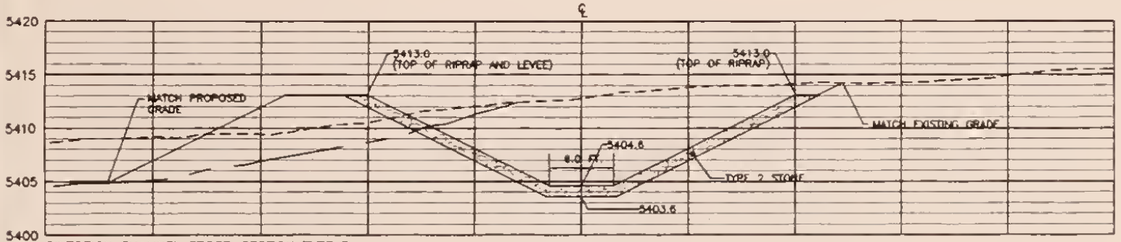
DIVERSION CHANNEL CROSS-SECTION TYPE A

D20+00



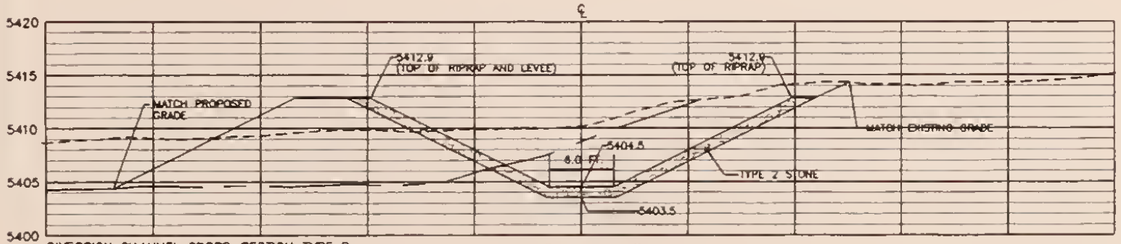
DIVERSION CHANNEL CROSS-SECTION TYPE A

D21+00



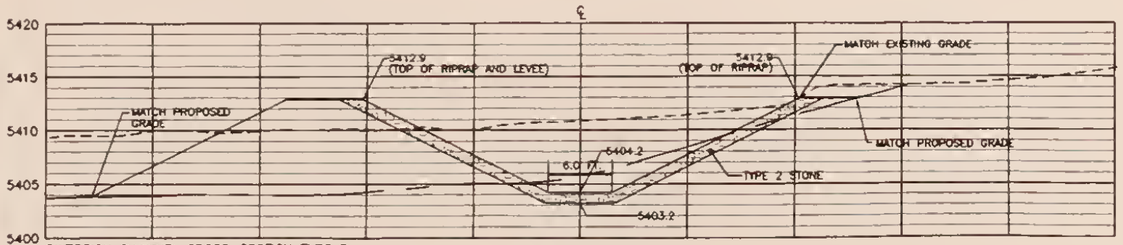
DIVERSION CHANNEL CROSS-SECTION TYPE B

D21+50



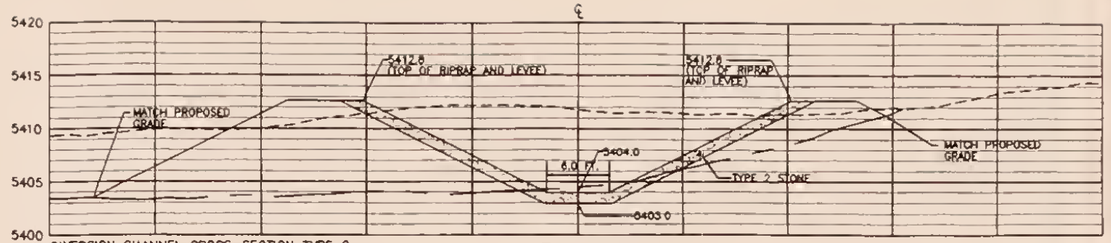
DIVERSION CHANNEL CROSS-SECTION TYPE B

D22+00



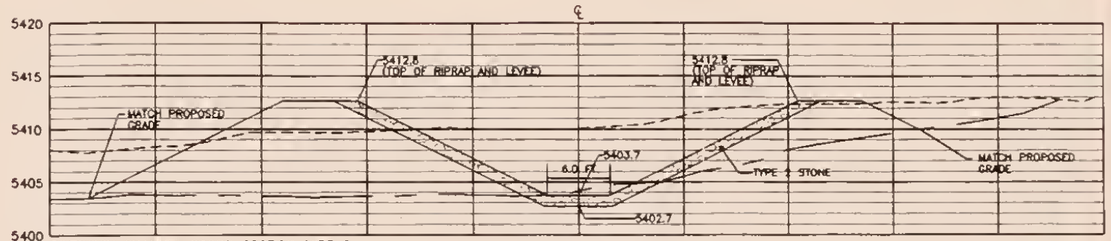
DIVERSION CHANNEL CROSS-SECTION TYPE B

D22+50



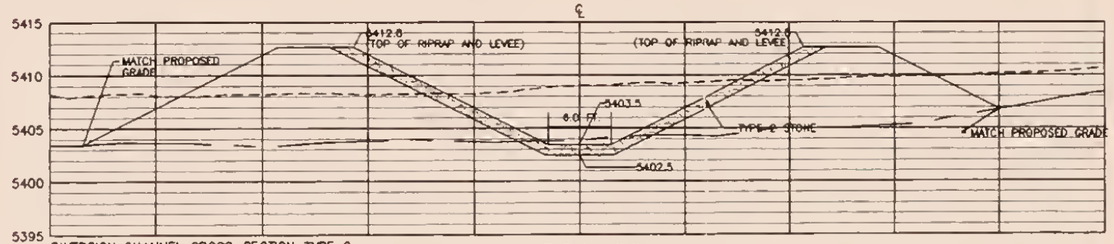
DIVERSION CHANNEL CROSS-SECTION TYPE C

D23+00



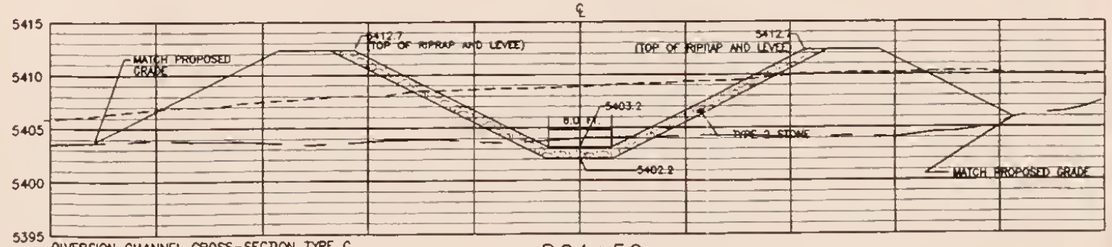
DIVERSION CHANNEL CROSS-SECTION TYPE C

D23+50



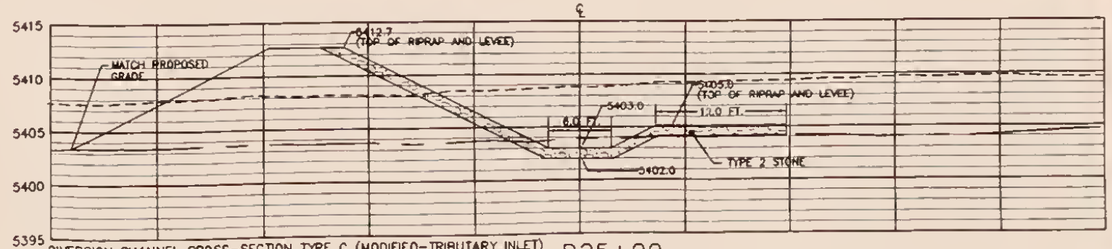
DIVERSION CHANNEL CROSS-SECTION TYPE C

D24+00



DIVERSION CHANNEL CROSS-SECTION TYPE C

D24+50



DIVERSION CHANNEL CROSS-SECTION TYPE C (MODIFIED-TRIBUTARY INLET)

D25+00

DIVERSION CHANNEL CROSS-SECTIONS
STA. D20+00 TO D25+00

INTEK-FLUVE,INC.

BOZEMAN, MONTANA

FINAL DESIGN
STREAMSIDE TAILINGS OPERABLE UNIT
SILVER BOW CREEK-SUBAREA 1-REACH A

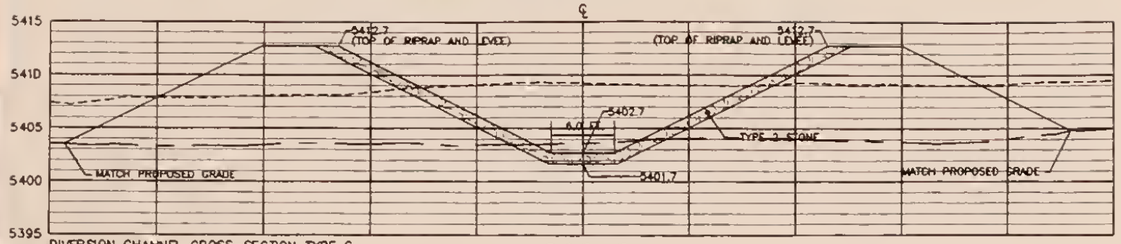
DESIGN BY: EJV	DRAWN BY: MAR	FILE: 118.DWG
DATE: 3-2-98	DATE: 06-07-99	DATE: 06-07-99

SHEET: 118 OF 127

PROPOSED GRADE

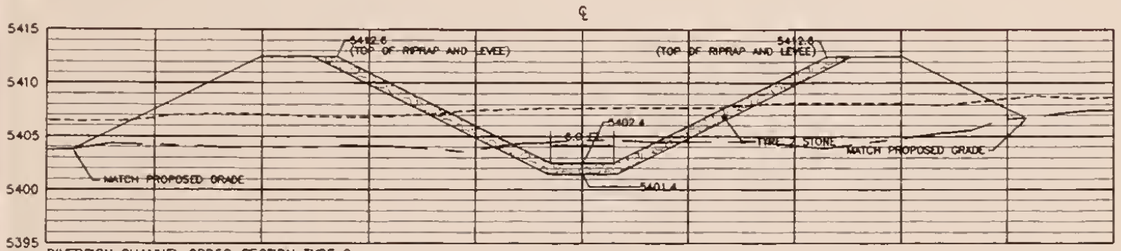
EXISTING GRADE

NOTE:
SOME SEGMENTS OF PROPOSED GRADE WILL NOT BE CONSTRUCTED UNTIL AFTER REMOVAL OF THE DIVERSION CHANNEL. PROPOSED GRADE IS SHOWN ON THE CROSS-SECTIONS FOR PURPOSES OF TIEING-IN TO THE DIVERSION CHANNEL WHERE APPLICABLE, AND FOR FUTURE CONSTRUCTION REFERENCE.



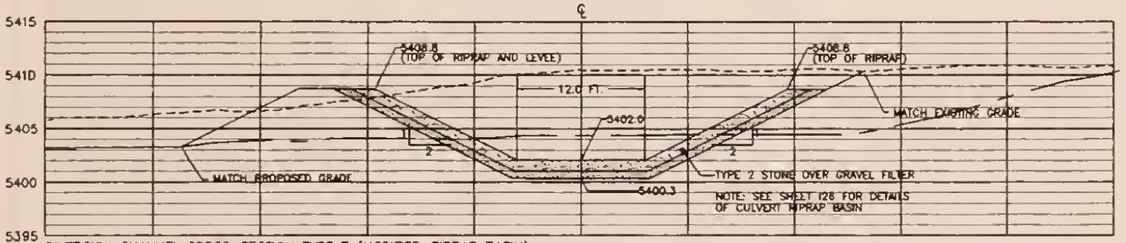
DIVERSION CHANNEL CROSS-SECTION TYPE C

D25+50



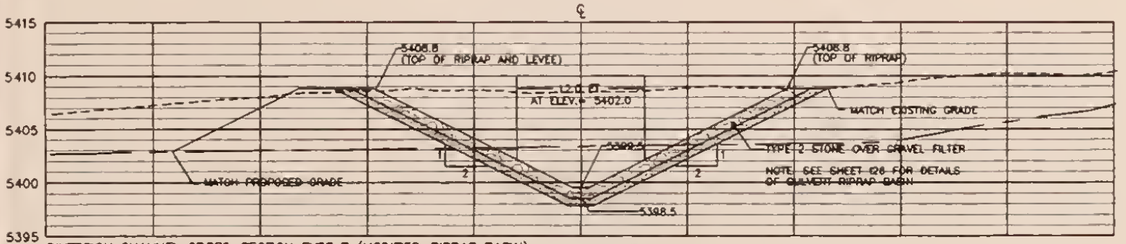
DIVERSION CHANNEL CROSS-SECTION TYPE C

D26+00



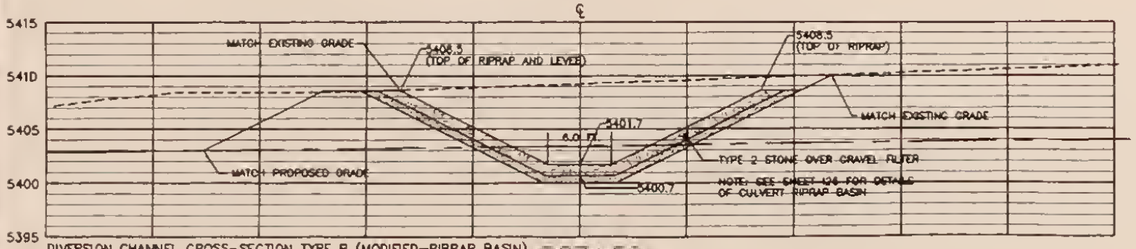
DIVERSION CHANNEL CROSS-SECTION TYPE B (MODIFIED-RIPRAP BASIN)

D27+00



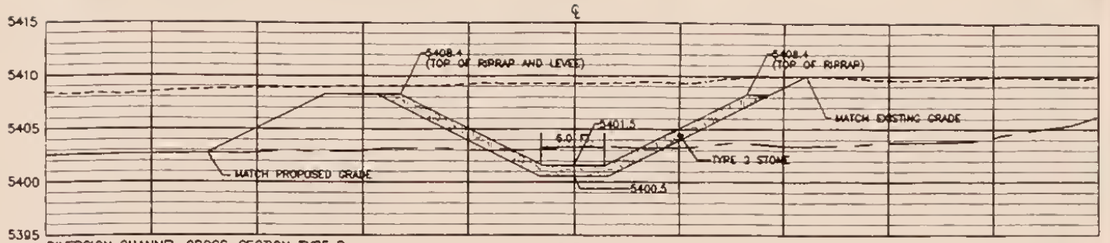
DIVERSION CHANNEL CROSS-SECTION TYPE B (MODIFIED-RIPRAP BASIN)

D27+15



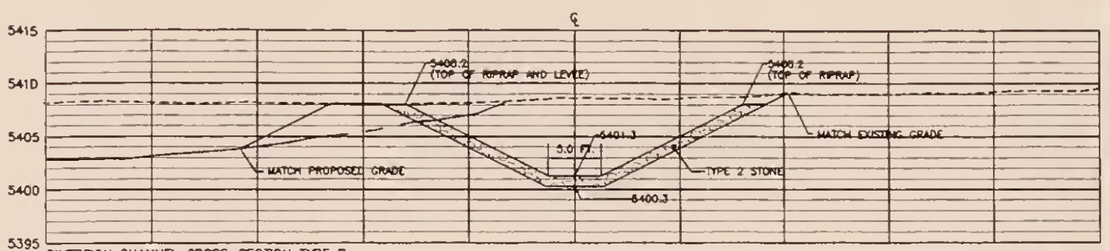
DIVERSION CHANNEL CROSS-SECTION TYPE B (MODIFIED-RIPRAP BASIN)

D27+50



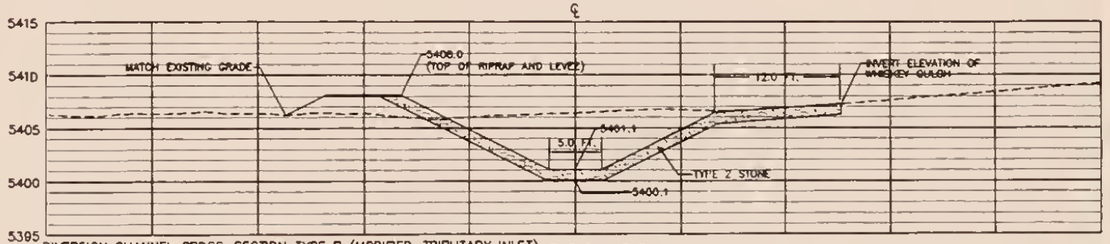
DIVERSION CHANNEL CROSS-SECTION TYPE B

D28+00



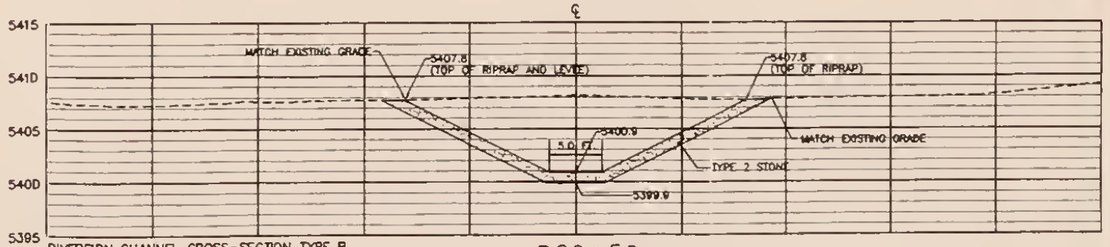
DIVERSION CHANNEL CROSS-SECTION TYPE B

D28+50



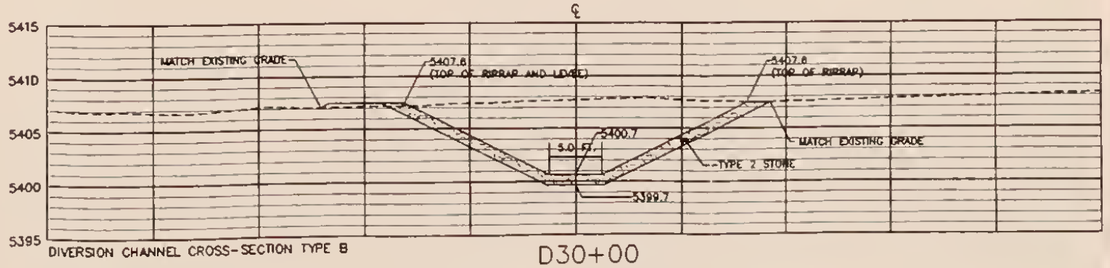
DIVERSION CHANNEL CROSS-SECTION TYPE B (MODIFIED-TRIBUTARY INLET)

D29+00



DIVERSION CHANNEL CROSS-SECTION TYPE B

D29+50



DIVERSION CHANNEL CROSS-SECTION TYPE B

D30+00

DIVERSION CHANNEL CROSS-SECTIONS
STA. D25+50 TO D30+00

INTER-FLUVE, INC.

FINAL DESIGN
STREAMSIDE TAILINGS OPERABLE UNIT
SILVER BOW CREEK-SUBAREA 1-REACH A

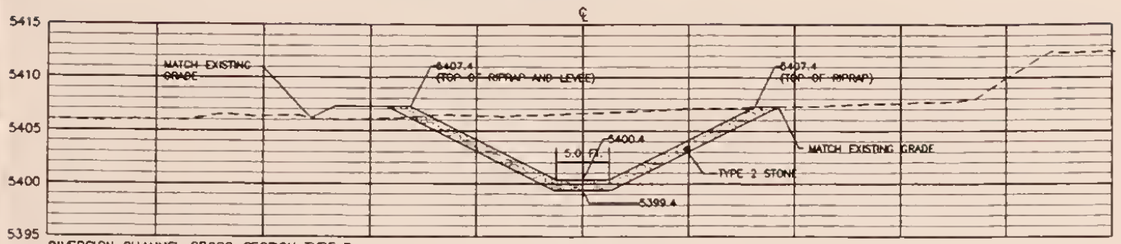
BY: E.V 3-2-98
BY: MAR 06-08-99
FILE: 119.DWG 06-08-99

SHEET:
119 of 127

PROPOSED GRADE

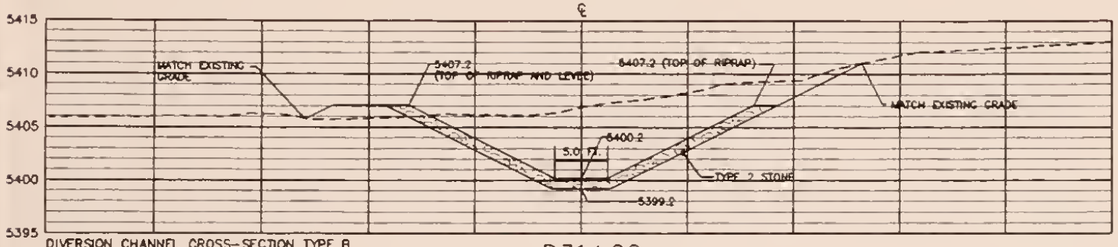
EXISTING GRADE

NOTE:
SOME SEGMENTS OF PROPOSED GRADE WILL NOT BE CONSTRUCTED UNTIL AFTER REMOVAL OF THE DIVERSION CHANNEL. PROPOSED GRADE IS SHOWN ON THE CROSS-SECTIONS FOR PURPOSES OF TIEING-IN TO THE DIVERSION CHANNEL, WHERE APPLICABLE, AND FOR FUTURE CONSTRUCTION REFERENCE.



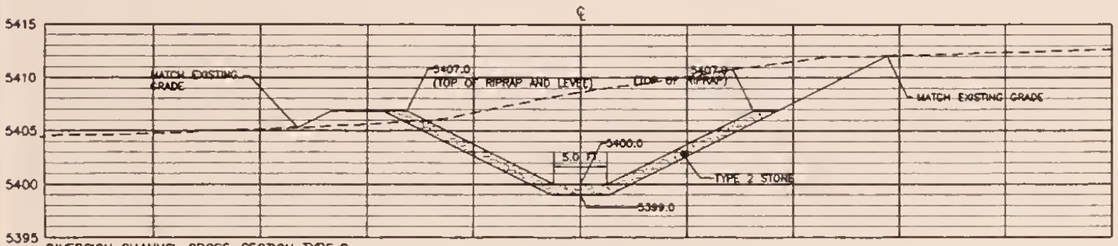
DIVERSION CHANNEL CROSS-SECTION TYPE B

D30+50



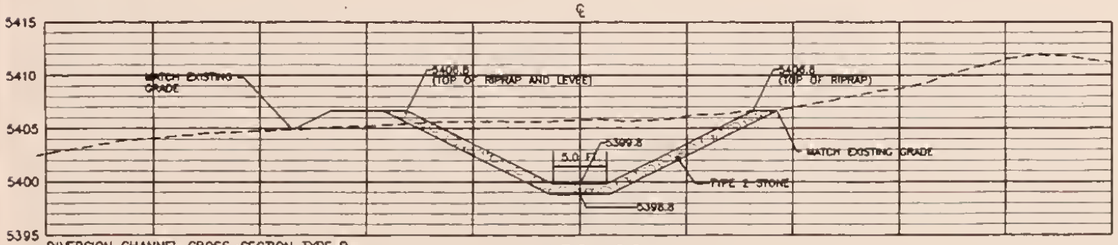
DIVERSION CHANNEL CROSS-SECTION TYPE B

D31+00



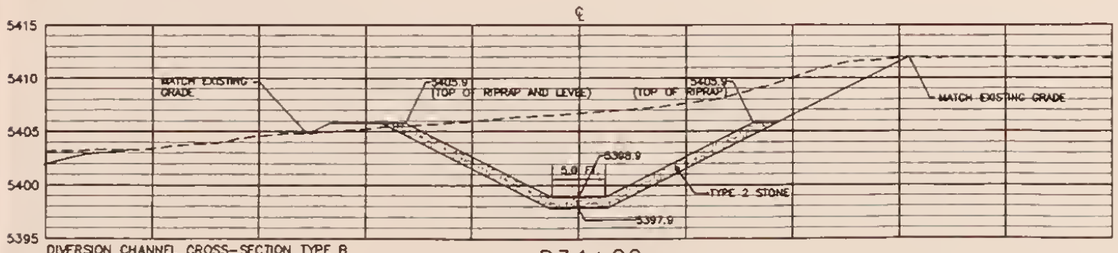
DIVERSION CHANNEL CROSS-SECTION TYPE B

D31+50



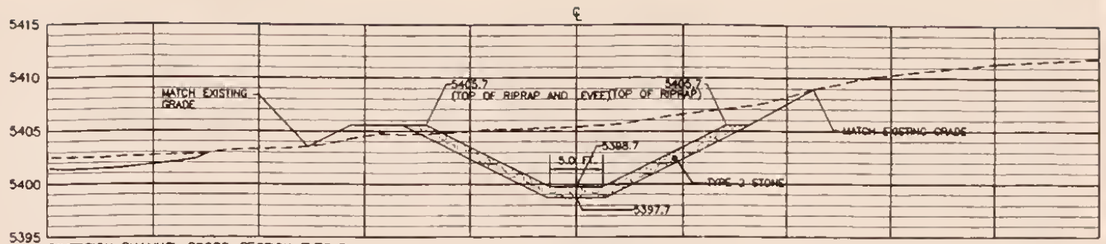
DIVERSION CHANNEL CROSS-SECTION TYPE B

D32+00



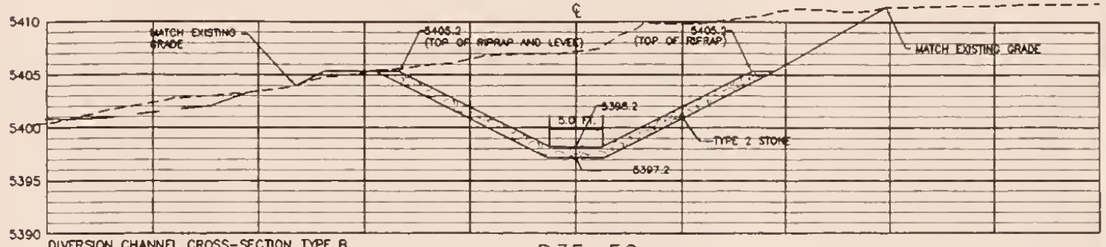
DIVERSION CHANNEL CROSS-SECTION TYPE B

D34+00



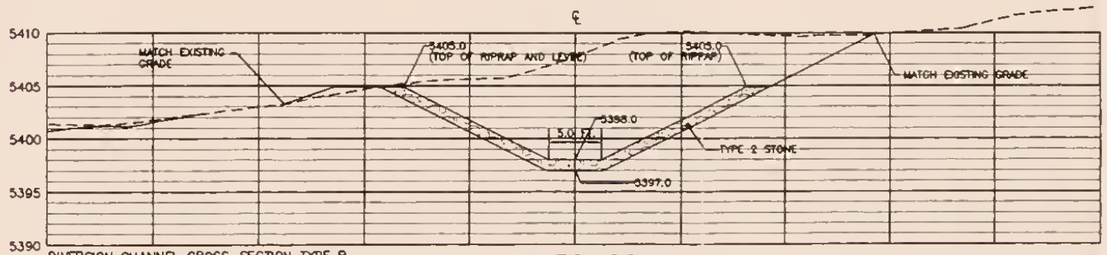
DIVERSION CHANNEL CROSS-SECTION TYPE B

D34+50



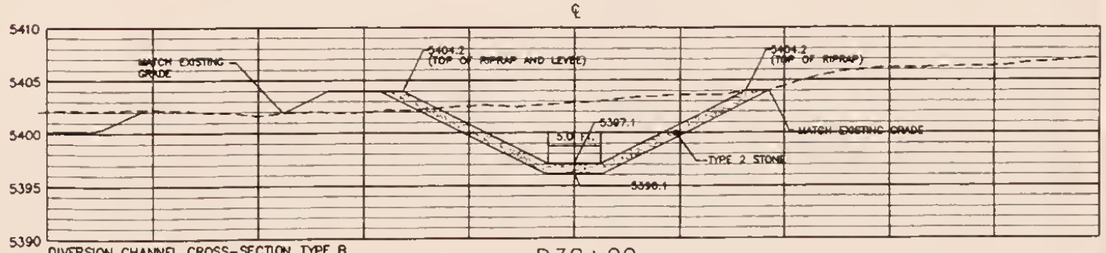
DIVERSION CHANNEL CROSS-SECTION TYPE B

D35+50



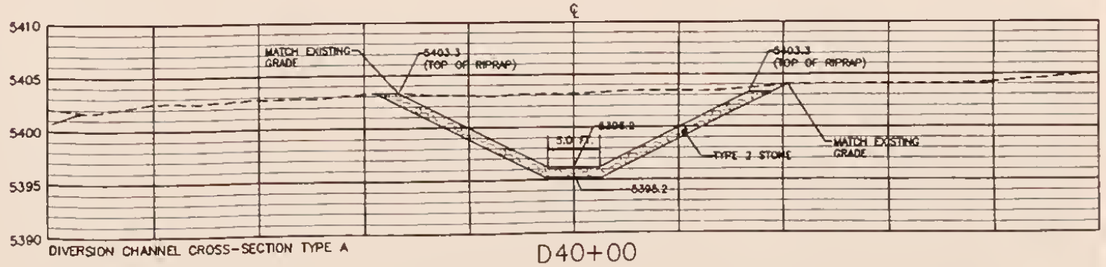
DIVERSION CHANNEL CROSS-SECTION TYPE B

D36+00



DIVERSION CHANNEL CROSS-SECTION TYPE B

D38+00



DIVERSION CHANNEL CROSS-SECTION TYPE A

D40+00

DIVERSION CHANNEL CROSS-SECTIONS
STA. D30+50 TO D40+00

INTER-FLUVE, INC.
BOZEMAN, MONTANA

FINAL DESIGN
STREAMSIDE TAILINGS OPERABLE UNIT
SILVER BOW CREEK-SUBAREA 1-REACH A

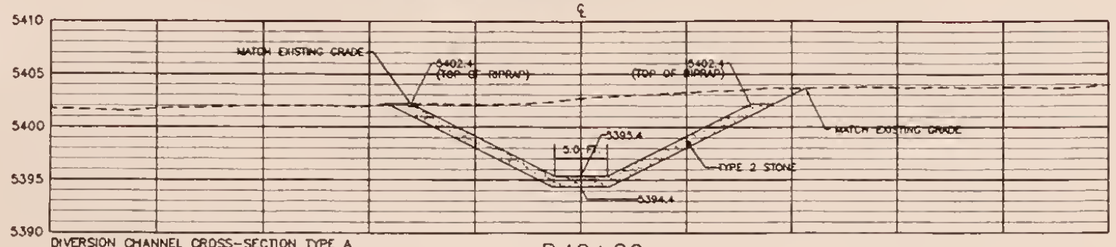
BY: E.J.V. 3-2-98
BY: M.MAR 06-08-99
FILE: 120.DWG 06-08-99

SHEET:
120 of 127

PROPOSED GRADE

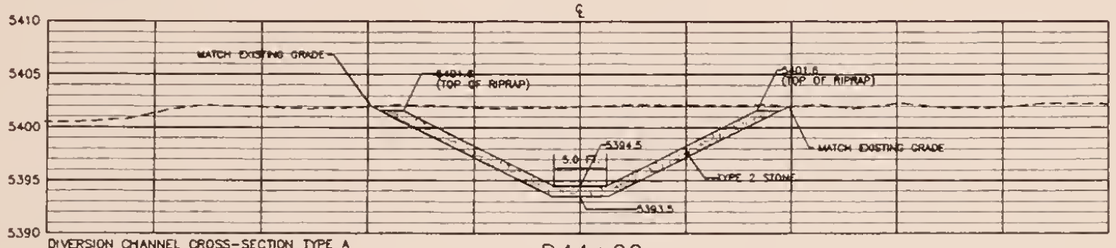
EXISTING GRADE

NOTE:
SOME SEGMENTS OF PROPOSED GRADE WILL NOT BE CONSTRUCTED UNTIL AFTER REMOVAL OF THE DIVERSION CHANNEL. PROPOSED GRADE IS SHOWN ON THE CROSS-SECTIONS FOR PURPOSES OF TIEING-IN TO THE DIVERSION CHANNEL WHERE APPLICABLE, AND FOR FUTURE CONSTRUCTION REFERENCE.



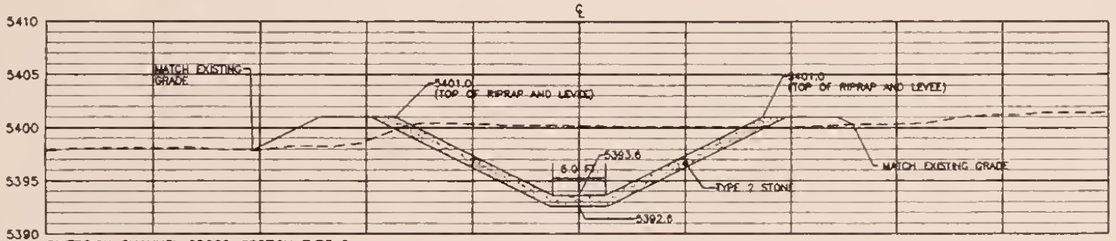
DIVERSION CHANNEL CROSS-SECTION TYPE A

D42+00



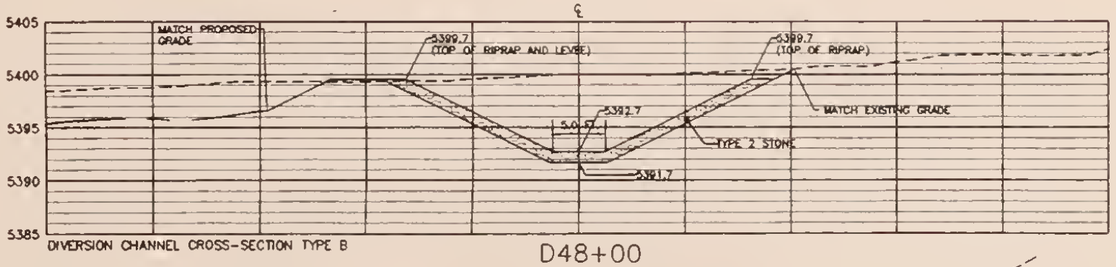
DIVERSION CHANNEL CROSS-SECTION TYPE A

D44+00



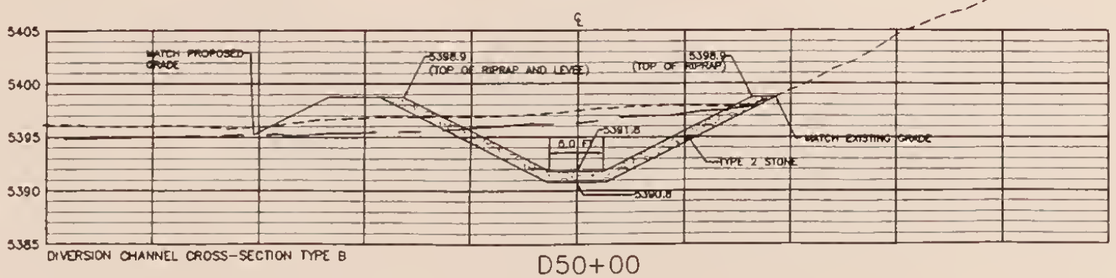
DIVERSION CHANNEL CROSS-SECTION TYPE C

D46+00



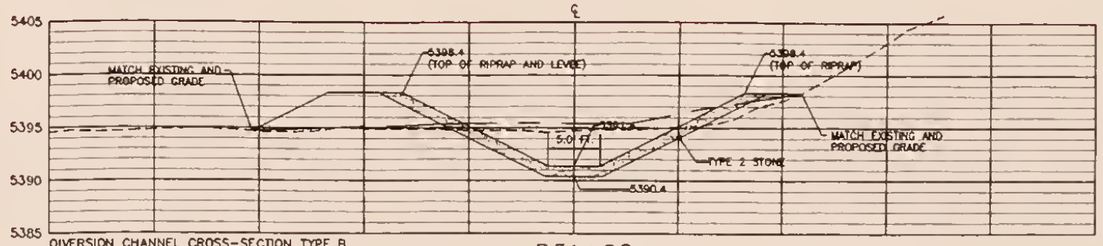
DIVERSION CHANNEL CROSS-SECTION TYPE B

D48+00



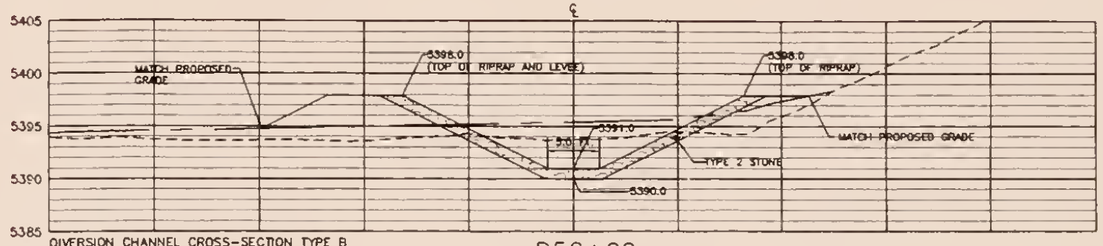
DIVERSION CHANNEL CROSS-SECTION TYPE B

D50+00



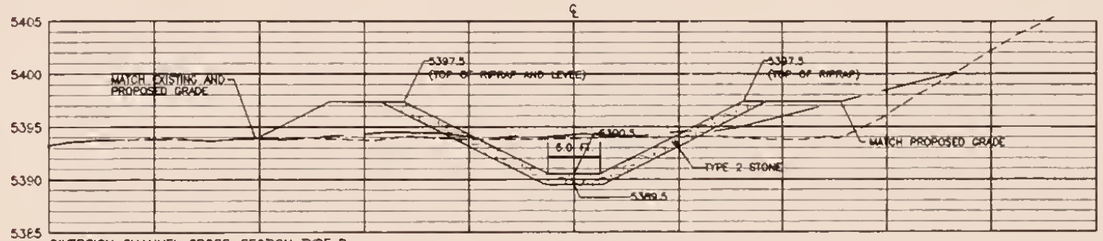
DIVERSION CHANNEL CROSS-SECTION TYPE B

D51+00



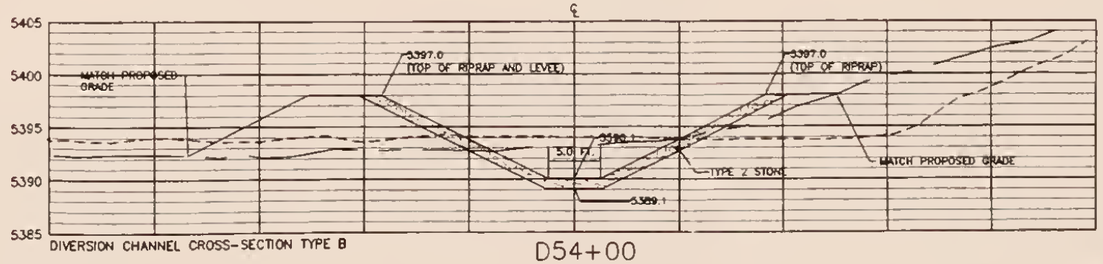
DIVERSION CHANNEL CROSS-SECTION TYPE B

D52+00



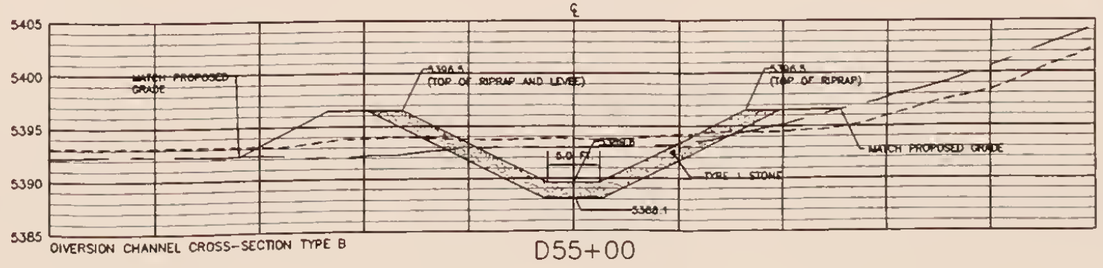
DIVERSION CHANNEL CROSS-SECTION TYPE B

D53+00



DIVERSION CHANNEL CROSS-SECTION TYPE B

D54+00



DIVERSION CHANNEL CROSS-SECTION TYPE B

D55+00

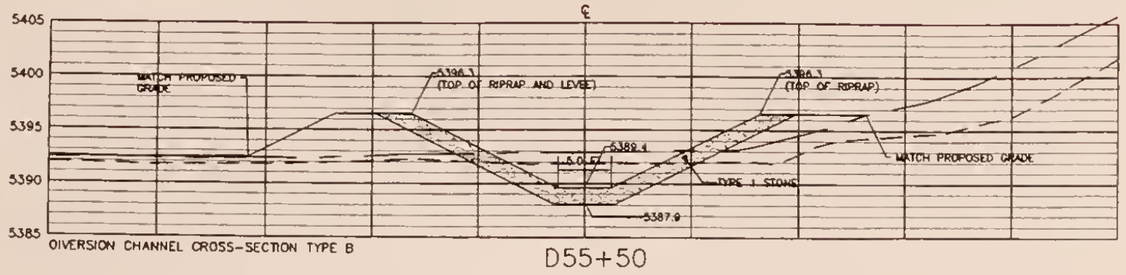
DIVERSION CHANNEL CROSS-SECTIONS
STA. D42+00 TO D55+00

INTER-FLUVE, INC.
BOZEMAN, MONTANA (406) 586-9626 HOOD RIVER, OREGON (541) 386-9003

FINAL DESIGN
TAILINGS OPERABLE UNIT
STREAMSIDE SUBAREA 1-REACH A
SILVER BOW CREEK

PROJECT NO. 5306.4 FOR
DRAWN BY: EJV
DATE: 3-2-98
APPROVED BY: MAR
DATE: 06-08-99
DRAWING FILE: I21.DWG
DATE: 06-08-99

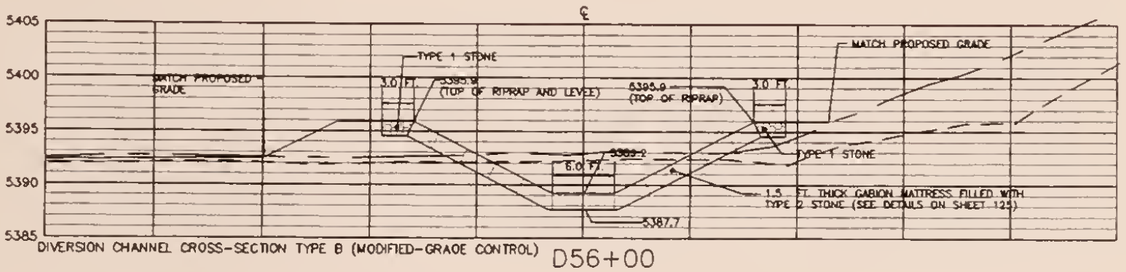
SHEET:
121 of 127



DIVERSION CHANNEL CROSS-SECTION TYPE B

D55+50

GRADUALLY TRANSITION DIVERSION CHANNEL BOTTOM WIDTH FROM 5 FT. TO 6 FT. BETWEEN STATIONS 055+50 AND 055+88.



DIVERSION CHANNEL CROSS-SECTION TYPE B (MODIFIED-GRADE CONTROL) D56+00

——— PROPOSED GRADE

– – – – EXISTING GRADE

NOTE:
SOME SEGMENTS OF PROPOSED GRADE WILL NOT BE CONSTRUCTED UNTIL AFTER REMOVAL OF THE DIVERSION CHANNEL. PROPOSED GRADE IS SHOWN ON THE CROSS-SECTIONS FOR PURPOSES OF TIEING-IN TO THE DIVERSION CHANNEL WHERE APPLICABLE, AND FOR FUTURE CONSTRUCTION REFERENCE.

DIVERSION CHANNEL CROSS-SECTIONS
STA. D55+50 TO D56+00

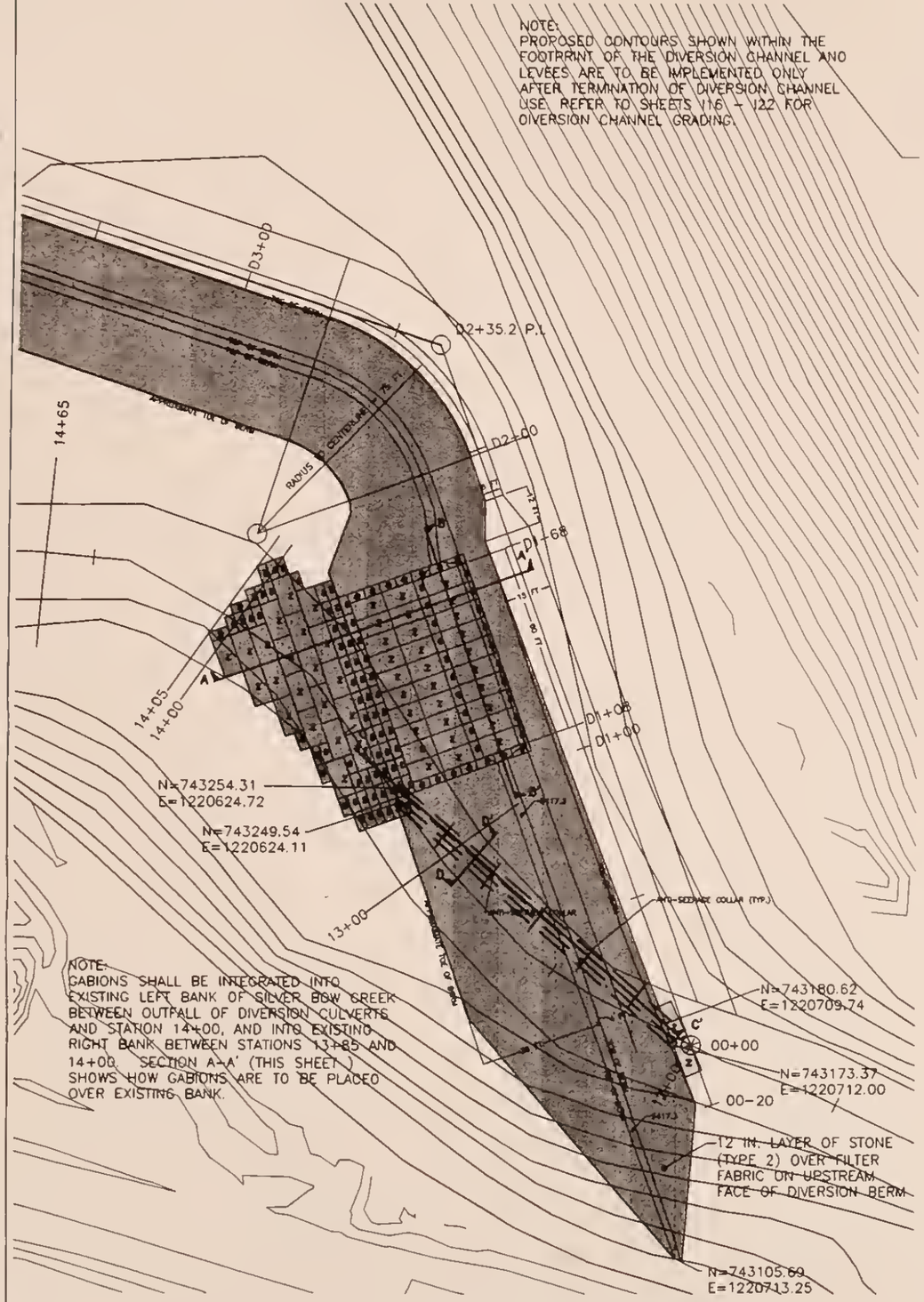
INTER-FLUVE, INC.
BOZEMAN, MONTANA (406) 586-8829 HOOD RIVER, OREGON (541) 386-9003

FINAL DESIGN
STREAMSIDE TAILINGS OPERABLE UNIT
SILVER BOW CREEK-SUBAREA 1-REACH A

DRAWN BY: EJV
DATE: 3-2-98
APPROVED BY: MAR
DATE: 06-08-99
DRAWING FILE: 122.DWG
DATE: 06-08-98

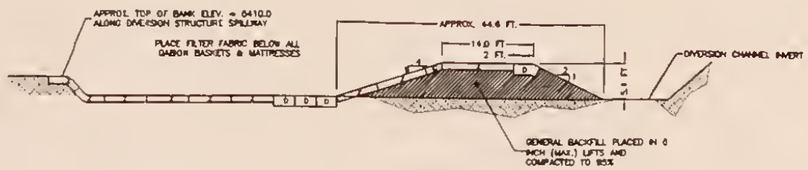
SHEET
122 of 127

NOTE:
PROPOSED CONTOURS SHOWN WITHIN THE FOOTPRINT OF THE DIVERSION CHANNEL AND LEVEES ARE TO BE IMPLEMENTED ONLY AFTER TERMINATION OF DIVERSION CHANNEL USE. REFER TO SHEETS 116 + 122 FOR DIVERSION CHANNEL GRADING.



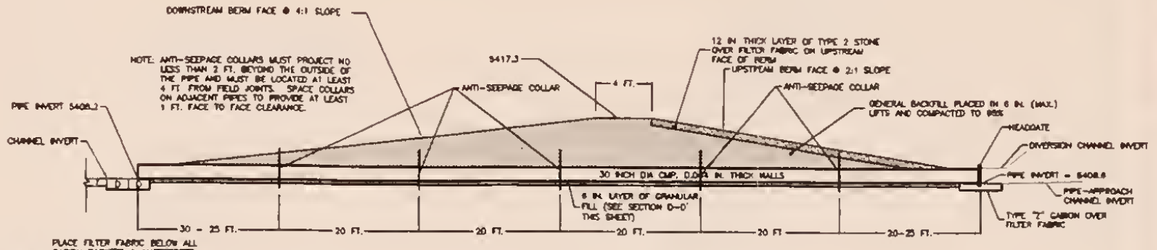
NOTE:
GABIONS SHALL BE INTEGRATED INTO EXISTING LEFT BANK OF SILVER BOW CREEK BETWEEN OUTFALL OF DIVERSION CULVERTS AND STATION 14+00, AND INTO EXISTING RIGHT BANK BETWEEN STATIONS 13+85 AND 14+00. SECTION A-A' (THIS SHEET) SHOWS HOW GABIONS ARE TO BE PLACED OVER EXISTING BANK.

PLAN VIEW OF DIVERSION STRUCTURE AREA
SCALE
1 IN. = 20 FT.
0 10 20 40 60

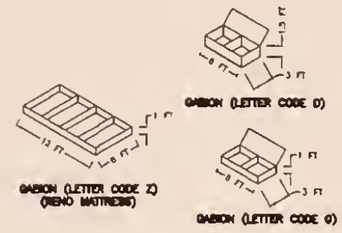

APPROX. TOP OF BANK ELEV. = 5410.0 ALONG DIVERSION STRUCTURE SPILLWAY
PLACE FILTER FABRIC BELOW ALL GABION BASKETS & MATTRESSES
APPROX. 44.6 FT.
16.0 FT.
2 FT.
5.6 FT.
DIVERSION CHANNEL INVERT
GENERAL BACKFILL PLACED IN 6 INCH (MAX.) LIFTS AND COMPACTED TO 95%

SECTION A-A' OF OVERFLOW SPILLWAY
NOT TO SCALE

SECTION B-B' OF OVERFLOW SPILLWAY CREST
NOTE: SCALE

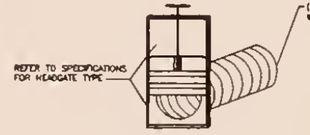

DOWNSTREAM BERM FACE @ 4:1 SLOPE
NOTE: ANTI-SEEPAGE COLLARS MUST PROJECT NO LESS THAN 2 FT. BEYOND THE OUTSIDE OF THE PIPE AND MUST BE LOCATED AT LEAST 4 FT. FROM FIELD JOINTS. SPACE COLLARS ON ADJACENT PIPES TO PROVIDE AT LEAST 3 FT. FACE TO FACE CLEARANCE.
5417.3
ANTI-SEEPAGE COLLAR
4 FT.
12 IN. THICK LAYER OF TYPE 2 STONE OVER FILTER FABRIC ON UPSTREAM FACE OF BERM
UPSTREAM BERM FACE @ 2:1 SLOPE
ANTI-SEEPAGE COLLAR
GENERAL BACKFILL PLACED IN 6 IN. (MAX.) LIFTS AND COMPACTED TO 95%
PIPE INVERT 5408.2
CHANNEL INVERT
HEADGATE
DIVERSION CHANNEL INVERT
PIPE INVERT = 5408.8
30 INCH DIA CMP, 0.064 IN. THICK WALLS
6 IN. LAYER OF GRANULAR FILL (SEE SECTION D-D' THIS SHEET)
PIPE-APPROACH CHANNEL INVERT
TYPE "Z" GABION OVER FILTER FABRIC
30 - 25 FT.
20 FT.
20 FT.
20 FT.
20 FT.
20-25 FT.
PLACE FILTER FABRIC BELOW ALL GABION BASKETS & MATTRESSES
PLACE FILTER FABRIC BELOW ALL GABION BASKETS & MATTRESSES

SECTION C-C' PROFILE VIEW OF CULVERT
NOT TO SCALE



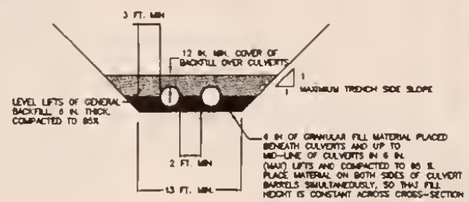
NOTE: GABIONS TO BE FILLED WITH TYPE 2 STONE AND UNDERLAIN BY FILTER FABRIC.

ISOMETRIC VIEW OF GABION MATTRESS
NOT TO SCALE

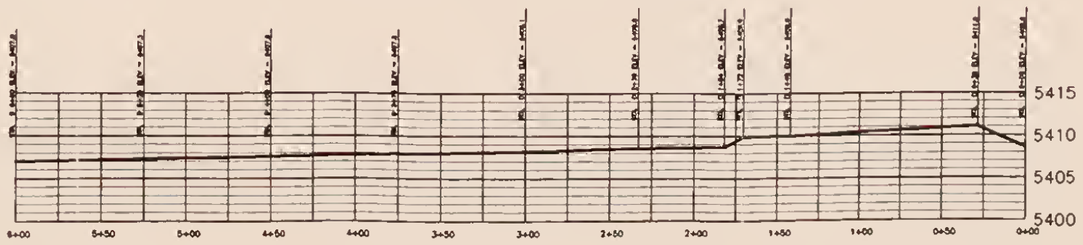

30" C.S.P., WALL THICKNESS = 0.064 IN. (CORRUGATION SIZE MUST BE COMPATIBLE WITH CULVERTS)
REFER TO SPECIFICATIONS FOR HEADGATE TYPE

ISOMETRIC VIEW OF HEADGATE
NOT TO SCALE

DETAIL: JOINING GABION TYPE D WITH Z AND G
NOT TO SCALE


3 FT. MIN
12 IN. MIN. COVER OF BACKFILL OVER CULVERTS
1 MAXIMUM TRENCH SIDE SLOPE
LEVEL LIFTS OF GENERAL BACKFILL, 6 IN. THICK, COMPACTED TO 85%
6 IN OF GRANULAR FILL MATERIAL PLACED BENEATH CULVERTS AND UP TO MID-LINE OF CULVERTS IN 6 IN. (MAX) LIFTS AND COMPACTED TO 85 %. PLACE MATERIAL ON BOTH SIDES OF CULVERT BARRELS SIMULTANEOUSLY, SO THAT FILL HEIGHT IS CONSTANT ACROSS CROSS-SECTION
2 FT. MIN
13 FT. MIN.

SECTION D-D' SECTION VIEW OF CULVERT BEDDING AND BACKFILL
NOT TO SCALE



DIVERSION CHANNEL LONGITUDINAL PROFILE THROUGH DIVERSION AREA
NOT TO SCALE

DIVERSION STRUCTURE DETAILS

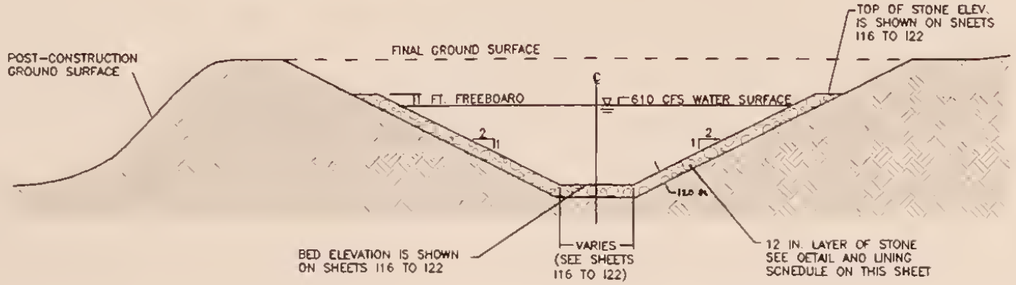
INTER-FLUVE, INC.
BOZEMAN, MONTANA PHONE (406) 585-0600

FINAL DESIGN
OPERABLE UNIT
STREAMSIDE TAILINGS
SILVER BOW CREEK-SUBAREA 1-REACH A

BY/DATE	REVISIONS

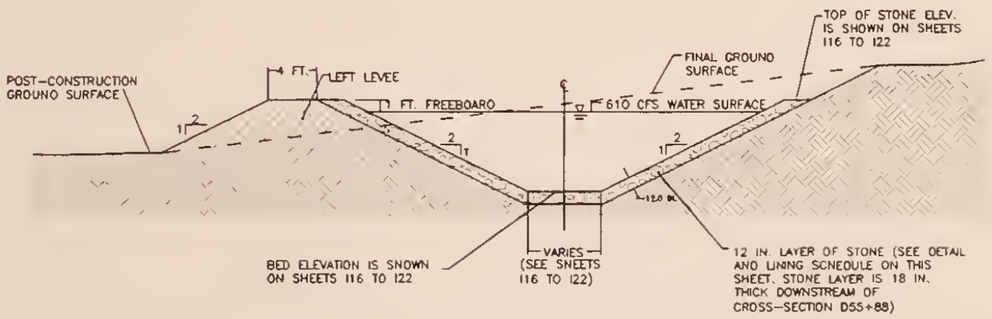
DRAWN BY: REP
DATE: 3-2-98
APPROVED BY: MAR
DATE: 06-08-99
DRAWING FILE: 123.DWG
DATE: 06-08-99

SHEET
123 of 127


POST-CONSTRUCTION GROUND SURFACE
FINAL GROUND SURFACE
TOP OF STONE ELEV. IS SHOWN ON SHEETS 116 TO 122
11 FT. FREEBOARD
610 CFS WATER SURFACE
2
1
1
2
12.0 ft
BED ELEVATION IS SHOWN ON SHEETS 116 TO 122
VARIES (SEE SHEETS 116 TO 122)
12 IN. LAYER OF STONE SEE DETAIL AND LINING SCHEDULE ON THIS SHEET

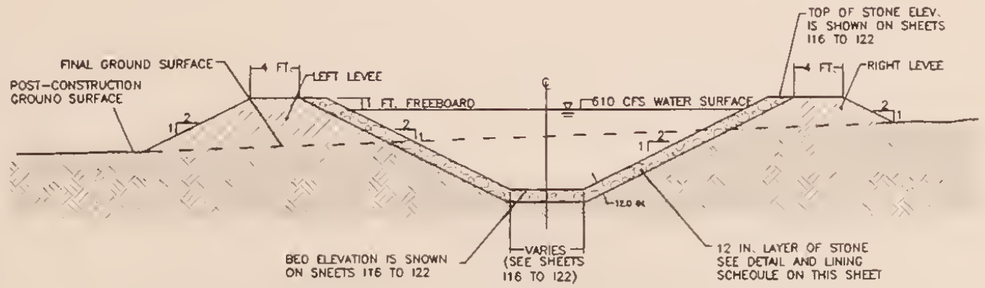
TYPICAL DIVERSION CHANNEL CROSS-SECTION : TYPE A

NOT TO SCALE


POST-CONSTRUCTION GROUND SURFACE
4 FT.
LEFT LEVEE
11 FT. FREEBOARD
610 CFS WATER SURFACE
FINAL GROUND SURFACE
TOP OF STONE ELEV. IS SHOWN ON SHEETS 116 TO 122
1
2
2
1
1
2
12.0 ft
BED ELEVATION IS SHOWN ON SHEETS 116 TO 122
VARIES (SEE SHEETS 116 TO 122)
12 IN. LAYER OF STONE (SEE DETAIL AND LINING SCHEDULE ON THIS SHEET. STONE LAYER IS 18 IN. THICK DOWNSTREAM OF CROSS-SECTION D55+88)

TYPICAL DIVERSION CHANNEL CROSS-SECTION : TYPE B

NOT TO SCALE



TYPICAL DIVERSION CHANNEL CROSS-SECTION : TYPE C

NOT TO SCALE

STONE MATERIAL GRADATIONS

MATERIAL TYPE	GRADATION	
TYPE 1 STONE	SIZE	% FINER BY WEIGHT
	15 IN.	100
	12 IN.	70-90
	9 IN.	40-60
	4 IN.	0-20
TYPE 2 STONE	SIZE	% FINER BY WEIGHT
	10 IN.	100
	8 IN.	70-90
	7 IN.	40-60
	3 IN.	0-20

DIVERSION CHANNEL LINING SCHEDULE

DIVERSION CHANNEL STATION	MATERIAL
D0-20 - D0+00	TYPE 2 STONE (ON DIVERSION STRUCTURE BERM UPSTREAM FACE)
D0+00 - D26+22 (CULVERT INLET)	TYPE 2 STONE
D26+92 (CULVERT OUTLET) - 027+57	TYPE 2 STONE OVER GRAVEL FILTER
027+57 - D54+88	TYPE 2 STONE
054+88 - 055+88	TYPE 1 STONE
D55+88 - 056+12	1.5 FT. THICK GABION MATTRESS (TYPE 2 STONE)
056+12 - 059+00	TYPE 1 STONE
ALL GABIONS	TYPE 2 STONE

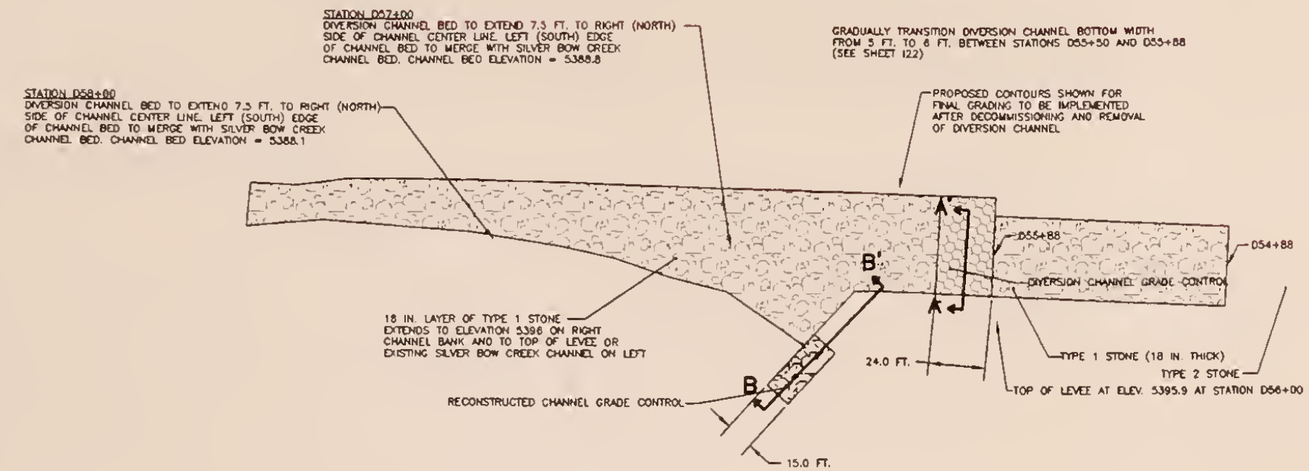
DIVERSION CHANNEL DETAILS

INTER-FLUVE, INC.
BOZEMAN, MONTANA (406) 586-0619 HOOD RIVER, OREGON (541) 386-6333

FINAL DESIGN
STREAMSIDE TAILINGS OPERABLE UNIT
SILVER BOW CREEK-SUBAREA 1-REACH A

DRAWN BY: REP
DATE: 3-2-98
APPROVED BY: MAR
DATE: 11-30-98
DRAWING FILE: 1124.DWG
DATE: 11-30-98

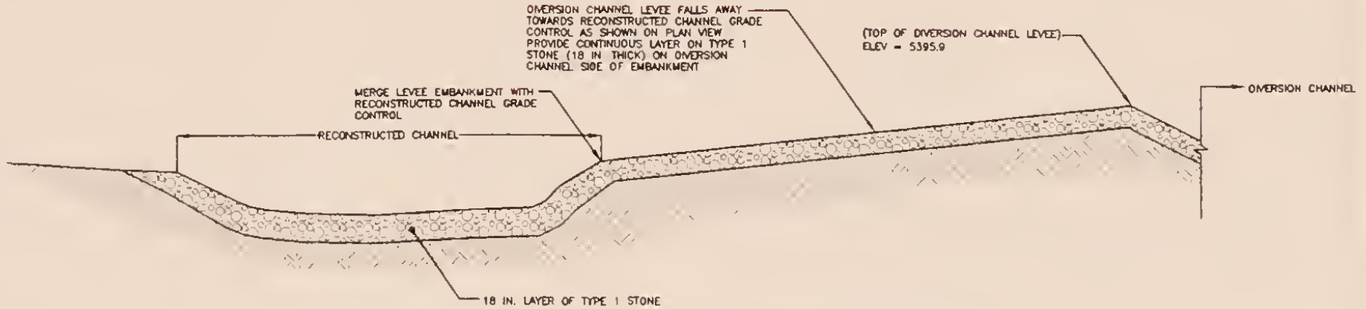
SHEET
124 of 127


STATION D57+00
DIVERSION CHANNEL BED TO EXTEND 7.5 FT. TO RIGHT (NORTH) SIDE OF CHANNEL CENTER LINE. LEFT (SOUTH) EDGE OF CHANNEL BED TO MERGE WITH SILVER BOW CREEK CHANNEL BED. CHANNEL BED ELEVATION = 5388.8
STATION D58+00
DIVERSION CHANNEL BED TO EXTEND 7.5 FT. TO RIGHT (NORTH) SIDE OF CHANNEL CENTER LINE. LEFT (SOUTH) EDGE OF CHANNEL BED TO MERGE WITH SILVER BOW CREEK CHANNEL BED. CHANNEL BED ELEVATION = 5388.1
GRADUALLY TRANSITION DIVERSION CHANNEL BOTTOM WIDTH FROM 5 FT. TO 8 FT. BETWEEN STATIONS D55+50 AND D55+88 (SEE SHEET 122)
PROPOSED CONTOURS SHOWN FOR FINAL GRADING TO BE IMPLEMENTED AFTER DECOMMISSIONING AND REMOVAL OF DIVERSION CHANNEL
D55+88
D54+88
DIVERSION CHANNEL GRADE CONTROL
B'
A
A'
18 IN. LAYER OF TYPE 1 STONE EXTENDS TO ELEVATION 5388 ON RIGHT CHANNEL BANK AND TO TOP OF LEVEE OR EXISTING SILVER BOW CREEK CHANNEL ON LEFT
B
RECONSTRUCTED CHANNEL GRADE CONTROL
24.0 FT.
15.0 FT.
TYPE 1 STONE (18 IN. THICK)
TYPE 2 STONE
TOP OF LEVEE AT ELEV. 5395.9 AT STATION D56+00

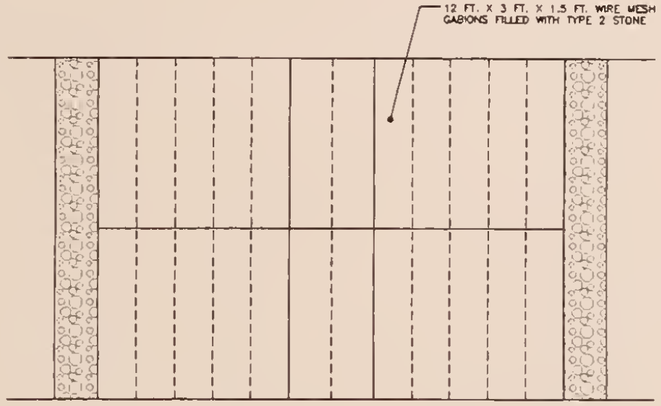
PLAN VIEW
NOT TO SCALE

GRAVEL FILTER/GRANULAR FILL SPECIFICATIONS

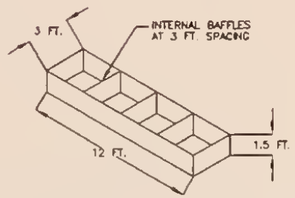
MATERIAL TYPE	GRADATION		THICKNESS	APPLICATION
	SIZE	% FINER BY WEIGHT		
GRAVEL FILTER/ GRANULAR FILL	1.25 IN	100	6 IN. LAYER WHERE CALLED OUT ON DRAWINGS	USED AS FILTER UNDER LOOSE STONE MATERIAL AND AS BEDDING MATERIAL BENEATH CULVERTS
	1 IN	80–100		
	NO. 4	35–70		
	NO. 20	10–20		
	NO. 40	0–5		


DIVERSION CHANNEL LEVEE FALLS AWAY TOWARDS RECONSTRUCTED CHANNEL GRADE CONTROL AS SHOWN ON PLAN VIEW PROVIDE CONTINUOUS LAYER ON TYPE 1 STONE (18 IN. THICK) ON DIVERSION CHANNEL SIDE OF EMBANKMENT
(TOP OF DIVERSION CHANNEL LEVEE) ELEV = 5395.9
DIVERSION CHANNEL
MERGE LEVEE EMBANKMENT WITH RECONSTRUCTED CHANNEL GRADE CONTROL
RECONSTRUCTED CHANNEL
18 IN. LAYER OF TYPE 1 STONE

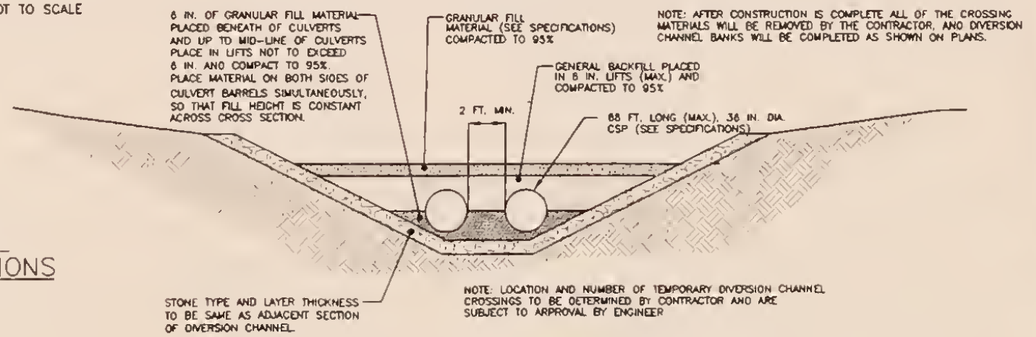
SECTION B–B' CROSS–SECTION OF RECONSTRUCTED CHANNEL GRADE CONTROL AND END OF DIVERSION CHANNEL LEVEE
NOT TO SCALE



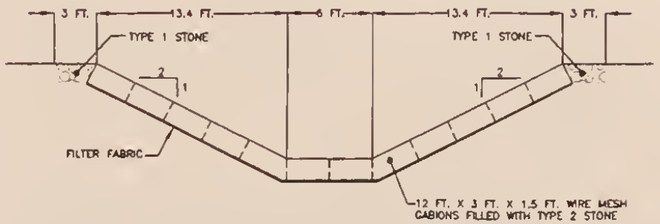
PLAN VIEW OF DIVERSION CHANNEL GRADE CONTROL
NOT TO SCALE



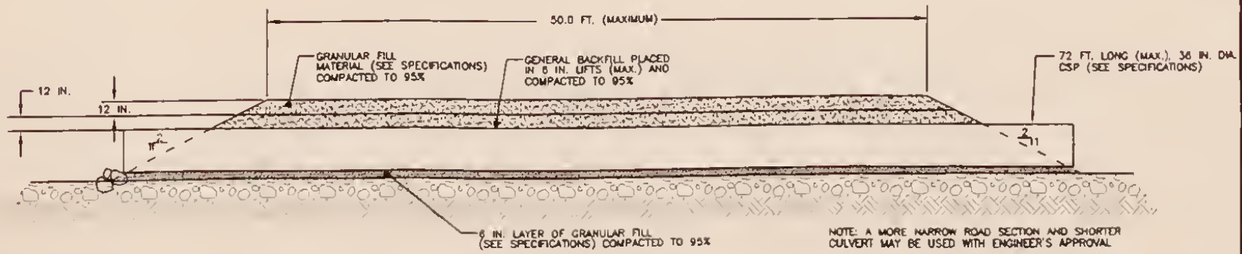
DETAIL OF DIVERSION CHANNEL (TYPE F) GRADE CONTROL GABIONS
NOT TO SCALE


6 IN. OF GRANULAR FILL MATERIAL PLACED BENEATH OF CULVERTS AND UP TO MID-LINE OF CULVERTS PLACE IN LIFTS NOT TO EXCEED 6 IN. AND COMPACT TO 95%. PLACE MATERIAL ON BOTH SIDES OF CULVERT BARRELS SIMULTANEOUSLY, SO THAT FILL HEIGHT IS CONSTANT ACROSS CROSS SECTION.
GRANULAR FILL MATERIAL (SEE SPECIFICATIONS) COMPACTED TO 95%
NOTE: AFTER CONSTRUCTION IS COMPLETE ALL OF THE CROSSING MATERIALS WILL BE REMOVED BY THE CONTRACTOR, AND DIVERSION CHANNEL BANKS WILL BE COMPLETED AS SHOWN ON PLANS.
GENERAL BACKFILL PLACED IN 6 IN. LIFTS (MAX.) AND COMPACTED TO 95%
2 FT. MIN.
68 FT. LONG (MAX.), 36 IN. DIA. CSP (SEE SPECIFICATIONS)
STONE TYPE AND LAYER THICKNESS TO BE SAME AS ADJACENT SECTION OF DIVERSION CHANNEL.
NOTE: LOCATION AND NUMBER OF TEMPORARY DIVERSION CHANNEL CROSSINGS TO BE DETERMINED BY CONTRACTOR AND ARE SUBJECT TO APPROVAL BY ENGINEER

CROSS–SECTION OF TEMPORARY HAUL ROAD CROSSING
NOT TO SCALE



SECTION A–A' CROSS–SECTION OF DIVERSION CHANNEL GRADE CONTROL
NOT TO SCALE


50.0 FT. (MAXIMUM)
GRANULAR FILL MATERIAL (SEE SPECIFICATIONS) COMPACTED TO 95%
GENERAL BACKFILL PLACED IN 6 IN. LIFTS (MAX.) AND COMPACTED TO 95%
72 FT. LONG (MAX.), 36 IN. DIA. CSP (SEE SPECIFICATIONS)
12 IN.
12 IN.
2
1
6 IN. LAYER OF GRANULAR FILL (SEE SPECIFICATIONS) COMPACTED TO 95%
NOTE: A MORE NARROW ROAD SECTION AND SHORTER CULVERT MAY BE USED WITH ENGINEER'S APPROVAL

LONGITUDINAL PROFILE THROUGH TEMPORARY HAUL ROAD CROSSING
NOT TO SCALE

DIVERSION CHANNEL OUTFALL AND HAUL ROAD CROSSING DETAILS

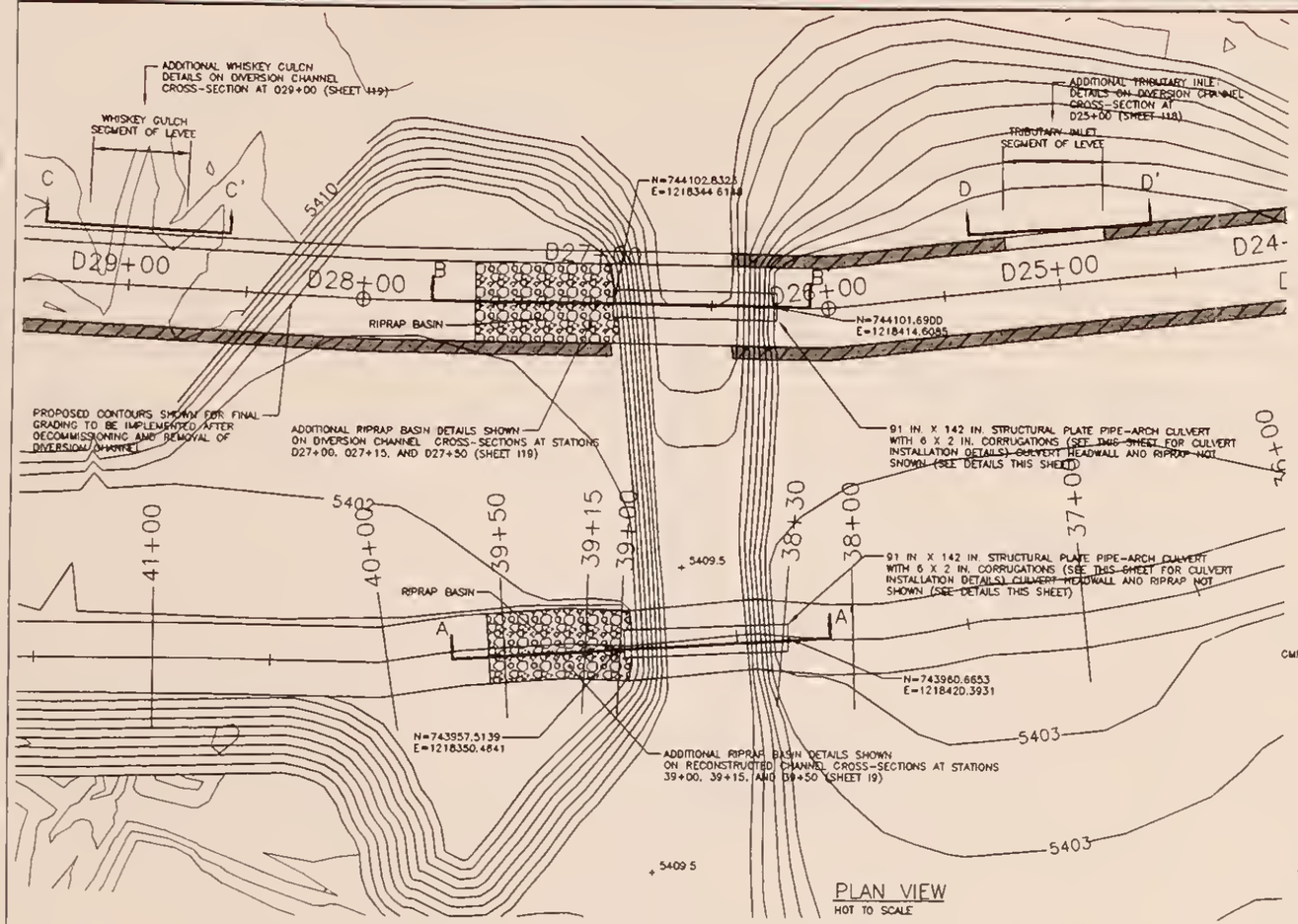
INTER-FLUVE, INC.
BOZEMAN, MONTANA 406-586-0277 HOOD, RIVER, OREGON 541-386-9003

FINAL DESIGN
STREAMSIDE TAILINGS OPERABLE UNIT
SILVER BOW CREEK–SUBAREA 1–REACH A

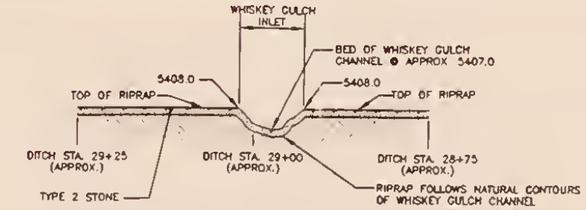
APPROVED BY/DATE	REVISIONS	FOR

DRAWN BY: REP
DATE: 3-2-98
APPROVED BY: MAR
DATE: 06-08-99
DRAWING FILE: 125.DWG
DATE: 06-08-99

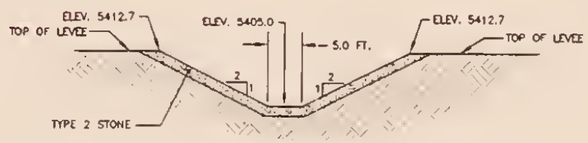
SHEET:
125 of 127


ADDITIONAL WHISKEY GULCH DETAILS ON DIVERSION CHANNEL CROSS-SECTION AT 029+00 (SHEET 119)
WHISKEY GULCH SEGMENT OF LEVEE
ADDITIONAL TRIBUTARY INLET DETAILS ON DIVERSION CHANNEL CROSS-SECTION AT D25+00 (SHEET 118)
TRIBUTARY INLET SEGMENT OF LEVEE
N=744102.8328
E=1218344.6148
D29+00
D28+00
D27+00
D26+00
D25+00
D24+
RIPRAP BASIN
N=744101.6900
E=1218414.6085
PROPOSED CONTOURS SHOWN FOR FINAL GRADING TO BE IMPLEMENTED AFTER DECOMMISSIONING AND REMOVAL OF DIVERSION CHANNEL
ADDITIONAL RIPRAP BASIN DETAILS SHOWN ON DIVERSION CHANNEL CROSS-SECTIONS AT STATIONS D27+00, 027+15, AND D27+50 (SHEET 119)
91 IN X 142 IN. STRUCTURAL PLATE PIPE-ARCH CULVERT WITH 6 X 2 IN. CORRUGATIONS (SEE DWG SHEET FOR CULVERT INSTALLATION DETAILS) CULVERT HEADWALL AND RIPRAP NOT SHOWN (SEE DETAILS THIS SHEET)
41+00
40+00
39+50
39+15
39+00
38+30
38+00
37+00
36+00
5402
5403
5409.5
RIPRAP BASIN
91 IN X 142 IN. STRUCTURAL PLATE PIPE-ARCH CULVERT WITH 6 X 2 IN. CORRUGATIONS (SEE THIS SHEET FOR CULVERT INSTALLATION DETAILS) CULVERT HEADWALL AND RIPRAP NOT SHOWN (SEE DETAILS THIS SHEET)
N=743960.6653
E=1218420.3931
N=743957.5139
E=1218350.4841
ADDITIONAL RIPRAP BASIN DETAILS SHOWN ON RECONSTRUCTED CHANNEL CROSS-SECTIONS AT STATIONS 39+00, 39+15, AND 39+50 (SHEET 19)

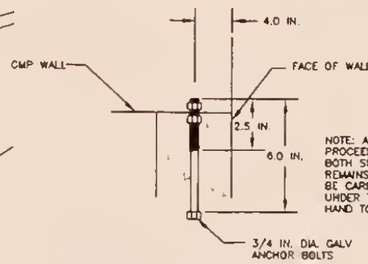
PLAN VIEW
HOT TO SCALE



SECTION C-C' WHISKEY GULCH INLET
NOT TO SCALE

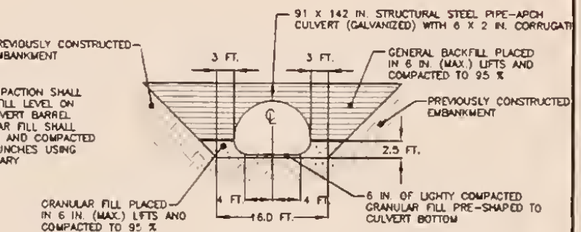


SECTION D-D' TRIBUTARY INLET AT STATION D25+00
NOT TO SCALE

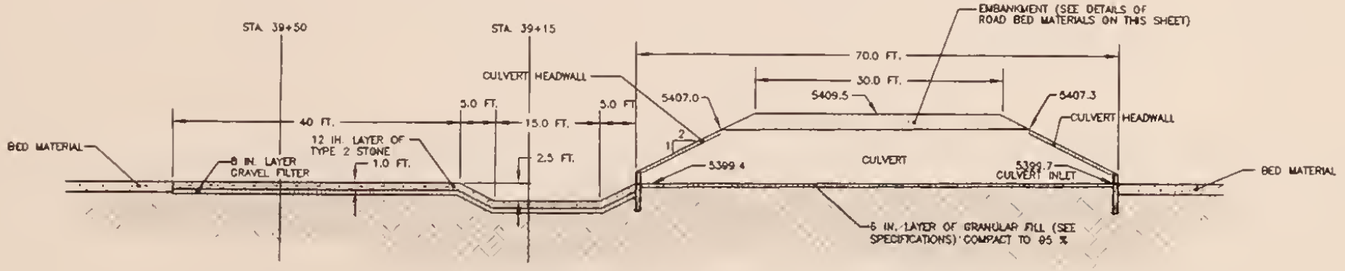


ANCHOR BOLT DETAILS
ANCHOR BOLT SPACING: USE MAX. SPACING OF 18 IN.

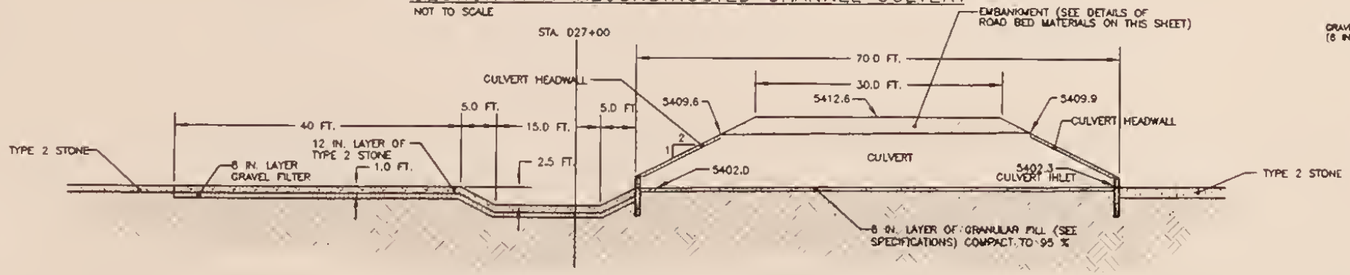
NOTE: ALL FILL AND COMPACTION SHALL PROCEED SO THAT THE FILL LEVEL ON BOTH SIDES OF THE CULVERT BARREL REMAINS EQUAL. GRANULAR FILL SHALL BE CAREFULLY INSTALLED AND COMPACTED UNDER THE CULVERT HAUNCHES USING HAND TOOLS IF NECCESSARY


91 X 142 IN. STRUCTURAL STEEL PIPE-ARCH CULVERT (GALVANIZED) WITH 6 X 2 IN. CORRUGATI
PREVIOUSLY CONSTRUCTED EMBANKMENT
3 FT.
3 FT.
GENERAL BACKFILL PLACED IN 6 IN. (MAX.) LIFTS AND COMPACTED TO 95 %
PREVIOUSLY CONSTRUCTED EMBANKMENT
2.5 FT.
GRANULAR FILL PLACED IN 6 IN. (MAX.) LIFTS AND COMPACTED TO 95 %
4 FT.
4 FT.
16.0 FT.
6 IN. OF LIGHTLY COMPACTED GRANULAR FILL PRE-SHAPED TO CULVERT BOTTOM

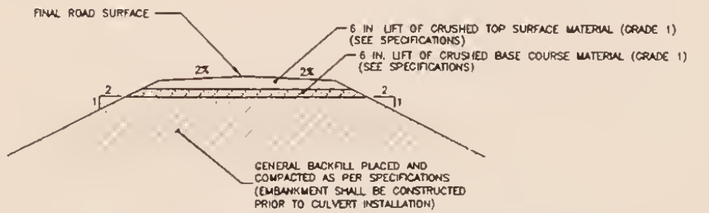
CULVERT BEDDING AND BACKFILL DETAIL
NOT TO SCALE



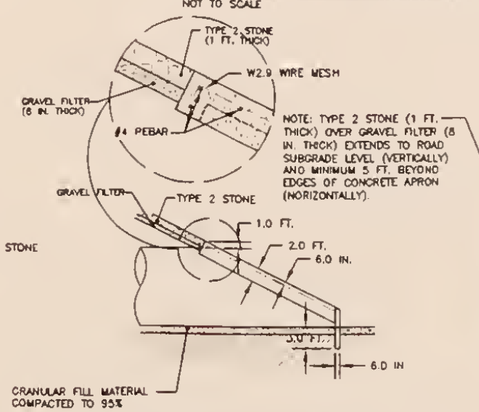
SECTION A-A' RECONSTRUCTED CHANNEL CULVERT
NOT TO SCALE



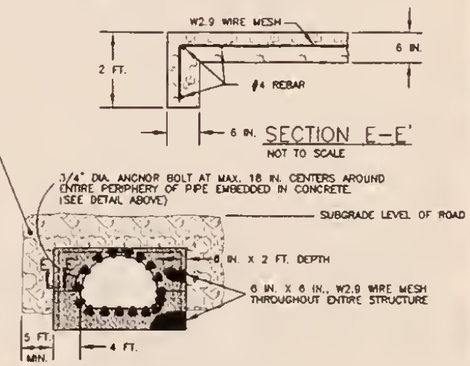
SECTION B-B' DIVERSION CHANNEL CULVERT
NOT TO SCALE


FINAL ROAD SURFACE
6 IN. LIFT OF CRUSHED TOP SURFACE MATERIAL (GRADE 1) (SEE SPECIFICATIONS)
6 IN. LIFT OF CRUSHED BASE COURSE MATERIAL (GRADE 1) (SEE SPECIFICATIONS)
2%
2%
2
1
2
1
GENERAL BACKFILL PLACED AND COMPACTED AS PER SPECIFICATIONS (EMBANKMENT SHALL BE CONSTRUCTED PRIOR TO CULVERT INSTALLATION)

CROSS-SECTION OF ROAD BED MATERIALS
NOT TO SCALE


TYPE 2 STONE (1 FT. THICK)
W2.9 WIRE MESH
GRAVEL FILTER (8 IN. THICK)
#4 REBAR
NOTE: TYPE 2 STONE (1 FT. THICK) OVER GRAVEL FILTER (8 IN. THICK) EXTENDS TO ROAD SUBGRADE LEVEL (VERTICALLY) AND MINIMUM 5 FT. BEYOND EDGES OF CONCRETE APRON (HORIZONTALLY).
GRAVEL FILTER
TYPE 2 STONE
1.0 FT.
2.0 FT.
6.0 IN.
3.0 FT.
6.0 IN
CRANULAR FILL MATERIAL COMPACTED TO 95%

CULVERT HEADWALL: SIDE ELEVATION
NOT TO SCALE


W2.9 WIRE MESH
6 IN.
2 FT.
#4 REBAR
6 IN.
3/4" DIA. ANCHOR BOLT AT MAX. 18 IN. CENTERS AROUND ENTIRE PERIPHERY OF PIPE EMBEDDED IN CONCRETE. (SEE DETAIL ABOVE)
SUBGRADE LEVEL OF ROAD
6 IN. X 2 FT. DEPTH
6 IN. X 6 IN., W2.9 WIRE MESH THROUGHOUT ENTIRE STRUCTURE
5 FT. MIN.
4 FT.

SECTION E-E'
NOT TO SCALE

CULVERT HEADWALL: FRONT ELEVATION
NOT TO SCALE

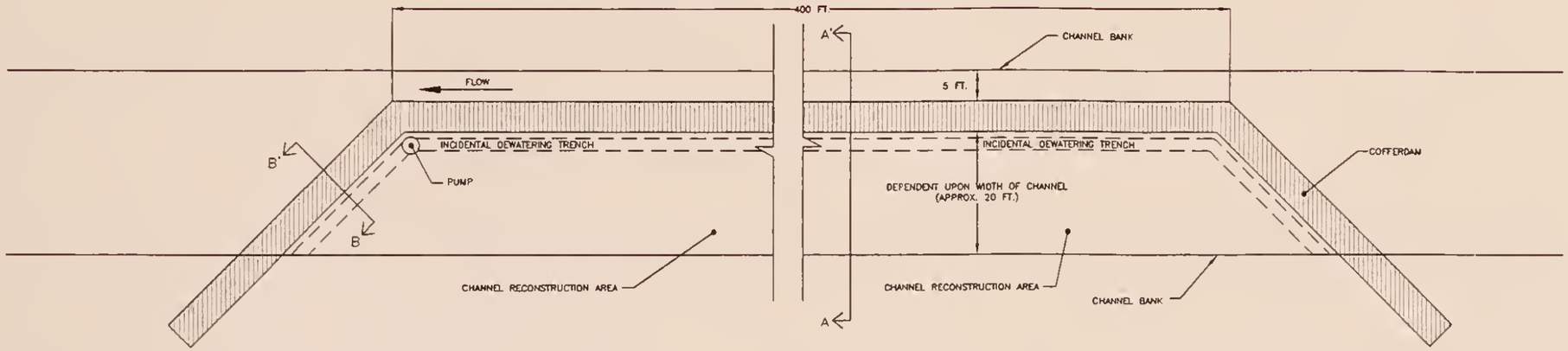
COUNTY ROAD CROSSING DETAILS

INTER-FLUVE, INC.
BOZEMAN, MONTANA

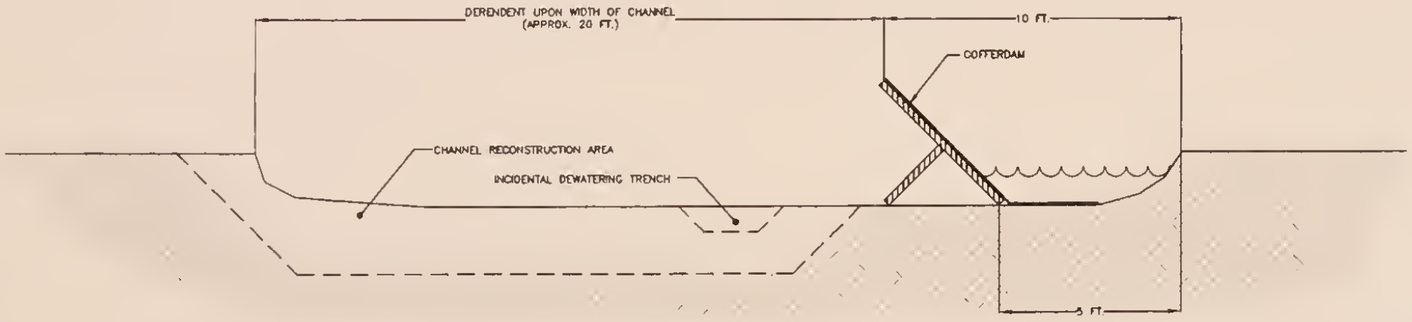
FINAL DESIGN
STREAMSIDE TAILINGS OPERABLE UNIT
SILVER BOW CREEK-SUBAREA 1-REACH A

BY: REP DATE: 3-2-98
BY: MAR DATE: 11-30-98
FILE: 126.DWG DATE: 11-30-98

SHEET
126, 127



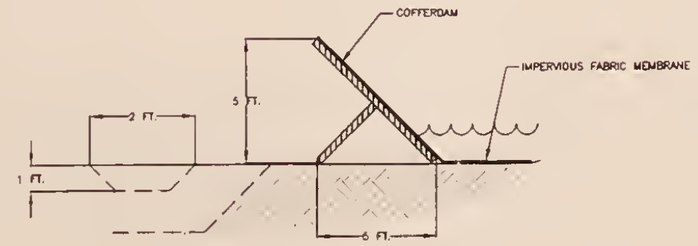
PLAN VIEW



CROSS-SECTION A-A'

NOTES:

1. AN APPROVED TYPE OF COFFERDAM IS THE PORT-A-DAM SYSTEM . REFER TO TECHNICAL SPECIFICATION SECTION 545.02 (p. 545-3) FOR DETAILS AND MANUFACTURER'S ADDRESS AND TELEPHONE NUMBER
2. COFFERDAM ENCLOSURES SHALL NOT EXTEND INTO CONSTRUCTION EXCLUSION AREAS BETWEEN STATIONS 0+00 AND 12+00.



CROSS-SECTION B-B'

DEWATERING COFFERDAM FOR NON-DEFORMABLE CHANNEL

INTER-FLUVE, INC.
POSTBOX, MONTANA (406) 585-9274 HOOD RIVER, OREGON (541) 386-6003

FINAL DESIGN
STREAMSIDE TAILINGS OPERABLE UNIT
SILVER BOW CREEK-SUBAREA 1-REACH A

REVISED BY/DATE	REMARKS

DRAWN BY: REP
DATE: 3-2-98
APPROVED BY: MAR
DATE: 06-08-99
DRAWING FILE: 127.DWG
DATE: 06-08-99

SHEET:
127 of 127

MONTANA
MINE WASTE CLEANUP BUREAU

GREENWAY SERVICE DISTRICT
IN COORDINATION WITH
MONTANA DEPARTMENT OF ENVIRONMENTAL QUALITY
MINE WASTE CLEANUP BUREAU

SILVER BOW CREEK GREENWAY SSTOU SUB-REACH (A)

BUTTE-SILVER BOW COUNTY, MONTANA

PREPARED BY

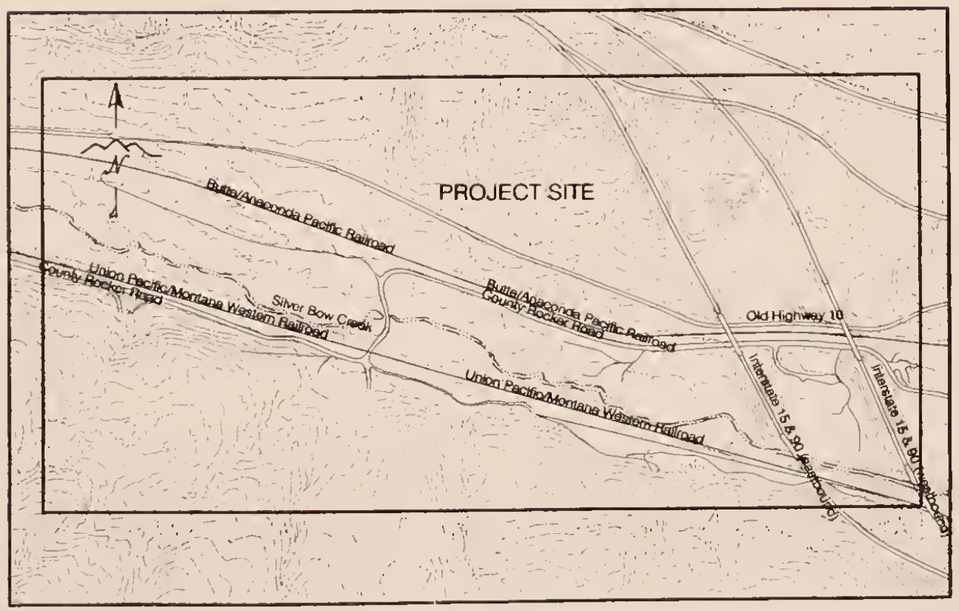
PIONEER TECHNICAL SERVICES, INC.

JUNE, 1999

MONTANA'S COPPERWAY
COPPERWAY REGIONAL TRAIL

LEGEND

- INTERMEDIATE CONTOUR
- INDEX CONTOUR
- RAILROAD
- EXISTING ROAD
- TRAIL STATION LABEL (20+00)
- STREAM/DIVERSION STATION LABELS (20 00)
- TRAIL CENTERLINE
- EDGE OF TRAIL
- APPROXIMATE WETLAND LOCATION
- TRAILHEAD LOCATION



SITE VICINITY MAP
NOT TO SCALE

MONTANA
JOEL L. GERHART
9742PE
REGISTERED
PROFESSIONAL ENGINEER

SHEET
P1

COUNTY ROAD

OLD HIGHWAY 10

RAPUS RAILROAD

BA&P RAILROAD (NRHP)

ROCKER/COUNTY ROAD

TRAIL, SEE DETAIL (A / P10) AND (B / P10)

FIRST DIVERSION CANAL CROSSING
END TRAIL CONSTRUCTION AT STA. 17+00.00
CROSSING TO BE INSTALLED AT A LATER TIME.

DIVERSION CANAL

I-15/90 NORTH/EAST

NEW SILVER BOW CREEK CHANNEL

RESUME TRAIL CONSTRUCTION
STA. 17+53.15

START TRAIL CONSTRUCTION
STA 12+00

MONTANA WESTERN RAILROAD

STREAM DIVERSION STRUCTURE

N

PIONEER TECHNICAL SERVICES, INC.
P.O. BOX 3445
BUTTE, MT 59702

DRAWN	DESIGNED	CHECKED
LJT	JLG	TWH
APPROVED	DATE	PROJECT NO.
JLG	1/8/99	8017-11

SCALE:
CONTOUR INTERVAL: 2'
SCALE IN FEET
0 50 100

NO.	BY	DATE	REVISION DESCRIPTION

GSD IN COORDINATION WITH MDEQ
SSTOU, SUBAREA 1, SUBREACH A
SILVER BOW CREEK GREENWAY

GREENWAY TRAIL ALIGNMENT
STA 12+00 TO 26+50

SHEET
P2

P2-SWI

WHISKEY GULCH STATION, ROUGH GRADE PARKING AREA. PLACE AND COMPACT 6" ROAD TOP AGGREGATE. SEE SHEET P11

NOT IN CONTRACT

COUNTY ROAD CROSSING. END TRAIL AT EDGES OF ROAD.

RESUME TRAIL CONSTRUCTION STA. 35+85.00

TRAIL, SEE DETAIL (A/P10) AND (B/P10)

SECOND DIVERSION CANAL CROSSING. END TRAIL CONSTRUCTION AT STA. 35+00.00. CROSSING TO BE INSTALLED AT A LATER TIME.

ROCKER COUNTY ROAD

RARUS RAILROAD

BASF RAILROAD (NRHP)

ROCKER/COUNTY ROAD

DIVERSION CANAL

MONTANA WESTERN RAILROAD

NEW SILVER BOW CREEK CHANNEL

PC = 38+70.60
PT = 39+14.45
PI = 38+05.67
PC = 36+20.91
PI = 33+61.77
PC = 32+47.08
PT = 31+10.72
PC = 30+84.51
PT = 30+94.89
PI = 28+35.50
PC = 26+77.00
PT = 26+92.72

PIONEER TECHNICAL SERVICES, INC.
P.O. BOX 3445
BUTTE, MT 59702

DRAWN	DESIGNED	CHECKED
LJT	JLC	TWH
APPROVED	DATE	PROJECT NO.
JLC	6/14/99	8017-11

SCALE
CONTOUR INTERVAL: 2'
SCALE IN FEET
0 50 100

NO	BY	DATE	REVISION DESCRIPTION

GSD IN COORDINATION WITH MDEQ
SSTOU, SUBAREA 1, SUBREACH A
SILVER BOW CREEK GREENWAY

GREENWAY TRAIL ALIGNMENT
STA 27+00 TO 40+50

SHEET
P3

TRAIL, SEE DETAIL A/P10 AND B/P10

TRAIL, SEE DETAIL A/P10 AND B/P10

NOT IN CONTRACT

WHISKEY GULCH STATION, ROUGH GRADE PARKING AREA. PLACE AND COMPACT 6" ROAD TOP AGGREGATE. SEE SHEET P11.

TRAIL CONNECTION, APPROX. STA. 40+50

THIRD DIVERSION CANAL CROSSING. END TRAIL AT STA. 41+13.74. CROSSING TO BE COMPLETED AT A LATER TIME.

RESUME TRAIL CONSTRUCTION AT STA. 55+77.44

THIRD DIVERSION CANAL CROSSING. RESUME TRAIL CONSTRUCTION STA. 42+32.19. CROSSING TO BE INSTALLED AT A LATER TIME.

MONTANA WESTERN RAILROAD

NEW SILVER BOW CREEK CHANNEL

PC = 51+59.20

PT = 49+55.07

PC = 48+17.49

PT = 47+56.23

PC = 46+14.95

PT = 43+80.59

PC = 42+27.19

PT = 40+94.89

PC = 38+70.60

PT = 39+14.39

PC = 38+84.51

PT = 54+71.46

N

PIONEER TECHNICAL SERVICES, INC. P.O. BOX 3445 BUTTE, MT 59702	LJT DRAWN	JLG DESIGNED	TWH CHECKED	SCALE: CONTOUR INTERVAL: 2' SCALE IN FEET 0 50 100	NO.	BY	DATE	REVISION DESCRIPTION
	JLG APPROVED	6/14/99 DATE	8017-11 PROJECT NO.					

GSD IN COORDINATION WITH MDEQ
SSTOU, SUBAREA 1, SUBREACH A
SILVER BOW CREEK GREENWAY

GREENWAY TRAIL ALIGNMENT
STA 41+00 TO 53+00

SHEET P4

DIVERSION CANAL

W SILVER BOW CREEK CHANNEL

TRAIL, SEE DETAIL (A / P10) AND (B / P10)

FIRST SILVER BOW CREEK CROSSING, END TRAIL CONSTRUCTION STA. 55+35.87. CROSSING TO BE CONSTRUCTED AT A LATER TIME.

NEW SILVER BOW CREEK CHANNEL

TRAIL, SEE DETAIL (A / P10) AND (B / P10)

RESUME TRAIL CONSTRUCTION AT STA. 55+77.44

RARUS RAILROAD

BA&P RAILROAD (NRHP)

DIVERSION CANAL

ROCKER COUNTY ROAD

MONTANA WESTERN RAILROAD

MONTANA

PT = 66+95.36

PC = 60+96.08

PT = 60+82.07

PC = 54+73.68

PT = 54+71.45

PC = 51+59.20

N

PIONEER TECHNICAL SERVICES, INC.
P.O. BOX 8445
BUTTE, MT 59702

LJT DRAWN	JLG DESIGNED	TWH CHECKED
JLG APPROVED	1/8/99 DATE	8017-11 PROJECT NO.

SCALE:
CONTOUR INTERVAL: 2'
SCALE IN FEET
0 50 100

NO.	BY	DATE	REVISION DESCRIPTION

GSD IN COORDINATION WITH MDEQ
SSTOU, SUBAREA 1, SUBREACH A
SILVER BOW CREEK GREENWAY

GREENWAY TRAIL ALIGNMENT
STA 53+50 TO 65+00

SHEET
P5

N

FARUS RAILROAD

BA&P RAILROAD (NRHP)

DIVERSION CANAL

NEW SILVER BOW CREEK CHANNEL

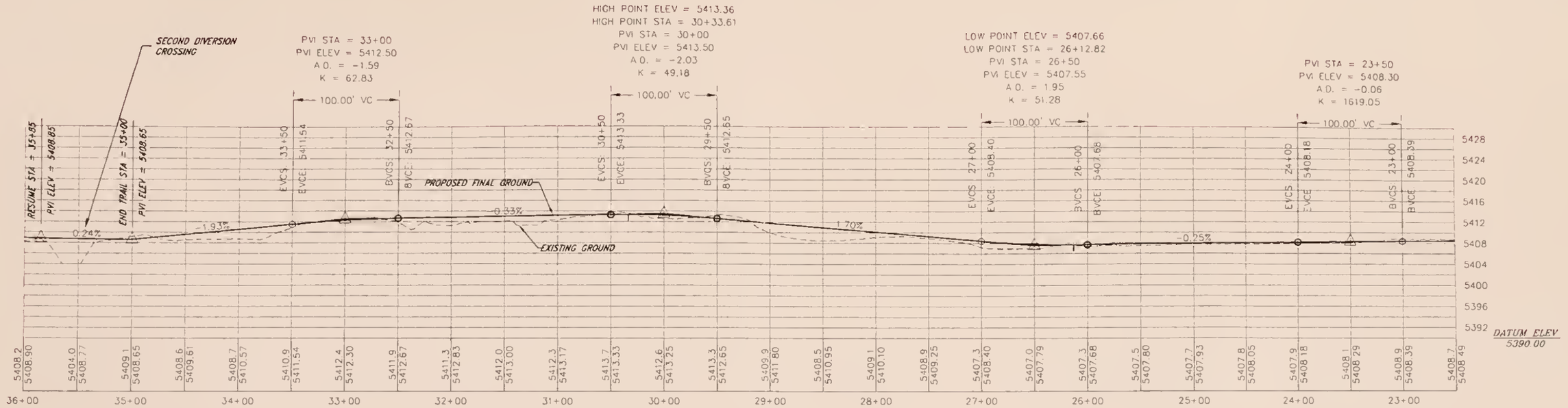
TRAIL, SEE DETAIL (A / P10) AND (B / P10)

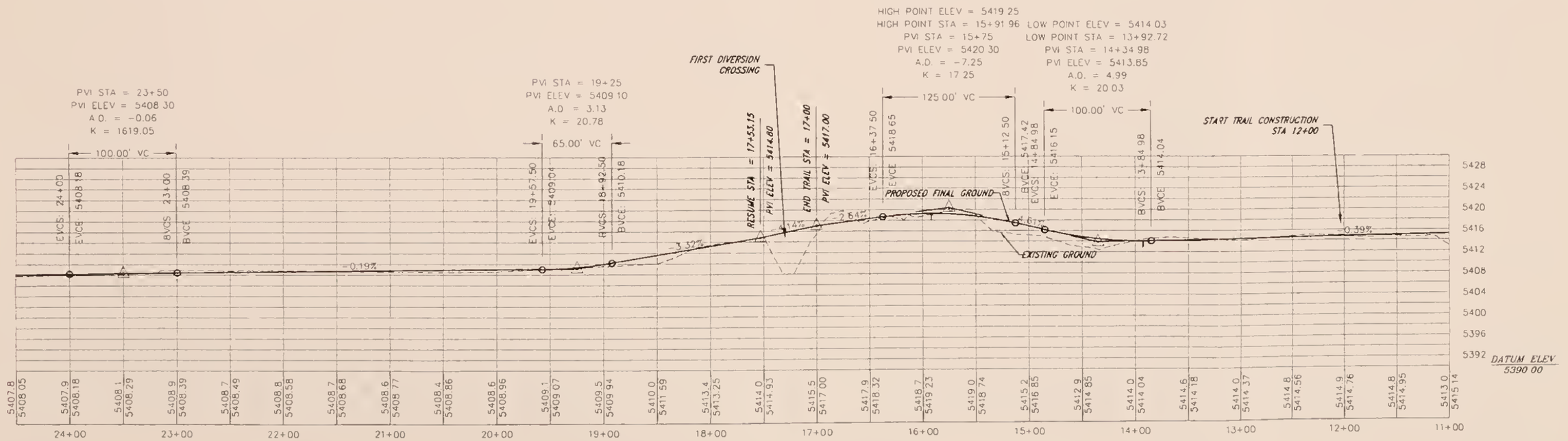
END TRAIL CONSTRUCTION
STA 69+00

ROCKER/COUNTY ROAD

ROCKER/COUNTY ROAD

| | | |





PIONEER TECHNICAL SERVICES, INC.
P.O. BOX 3445
BUTTE, MT 59702

LJT DRAWN	JLC DESIGNED	TWH CHECKED
JLC APPROVED	1/8/99 DATE	8017-11 PROJECT NO.

SCALE: CONTOUR INTERVAL: 2'
SCALE IN FEET
0 50 100

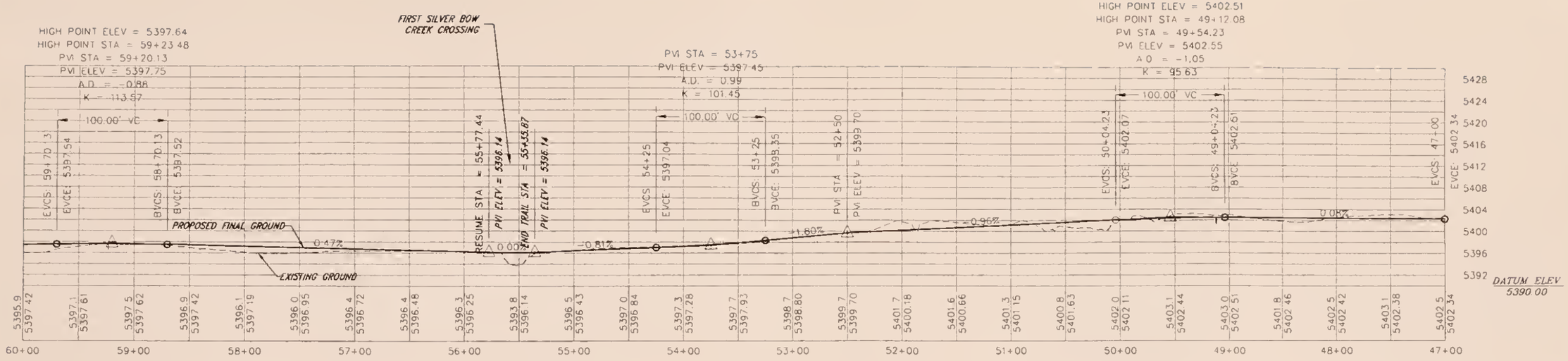
NO	BY	DATE	REVISION DESCRIPTION

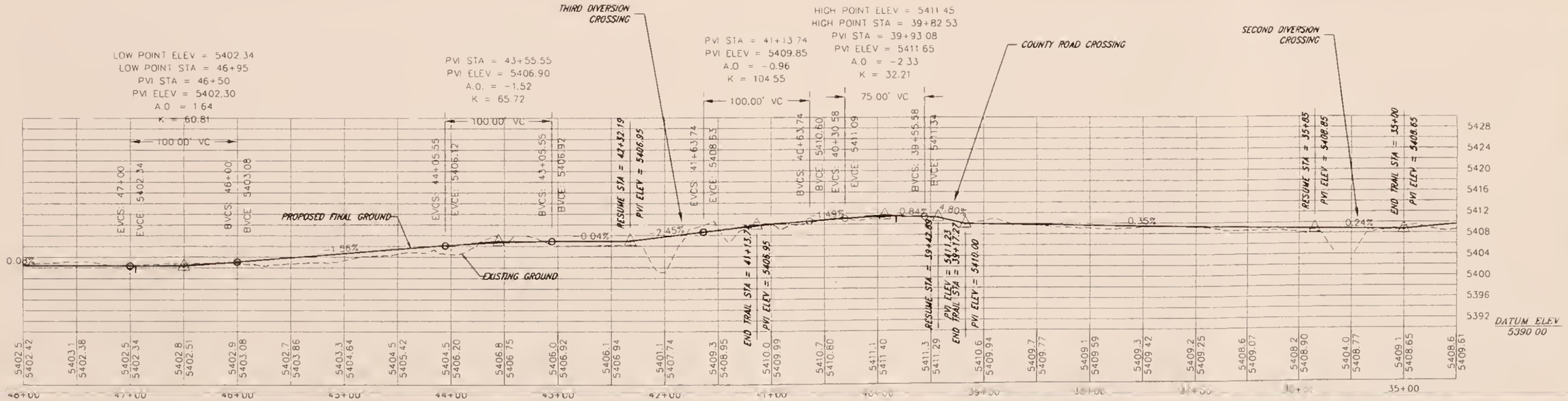
GSD IN COORDINATION WITH MDEQ
SSTOU, SUBAREA 1, SUBREACH A
SILVER BOW CREEK GREENWAY

GREENWAY TRAIL PROFILE
STA 12+00 TO 35+00

SHEET P7

P7-SWA1





PIONEER TECHNICAL SERVICES, INC.
P.O. BOX 3445
BUTTE, MT 59702

L.J.T. DRAWN	J.J.G. DESIGNED	T.W.H. CHECKED
J.J.G. APPROVED	1/8/99 DATE	8017-11 PROJECT NO.

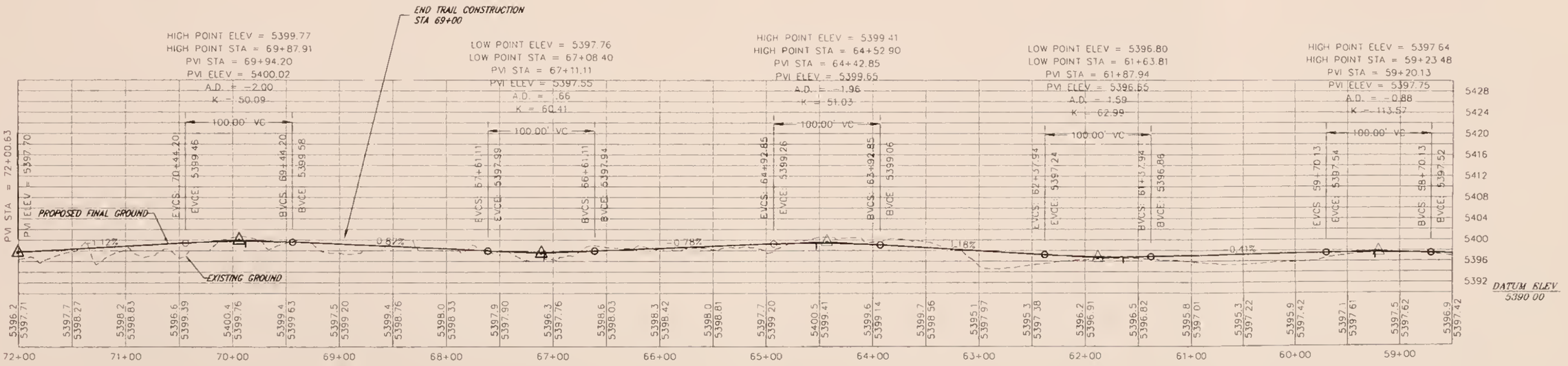
SCALE:
CONTOUR INTERVAL: 2'
SCALE IN FEET
0 50 100

NO.	BY	DATE	REVISION DESCRIPTION

GSD IN COORDINATION WITH MDEQ
SSTOU, SUBAREA 1, SUBREACH A
SILVER BOW CREEK GREENWAY

GREENWAY TRAIL PROFILE
STA 35+00 TO 59+00

SHEET
P8



PIONEER TECHNICAL SERVICES, INC.
P.O. BOX 3445
BUTTE, MT 59702

LJT DRAWN	JJG DESIGNED	TWH CHECKED
JJG APPROVED	1/11/99 DATE	B017-11 PROJECT NO.

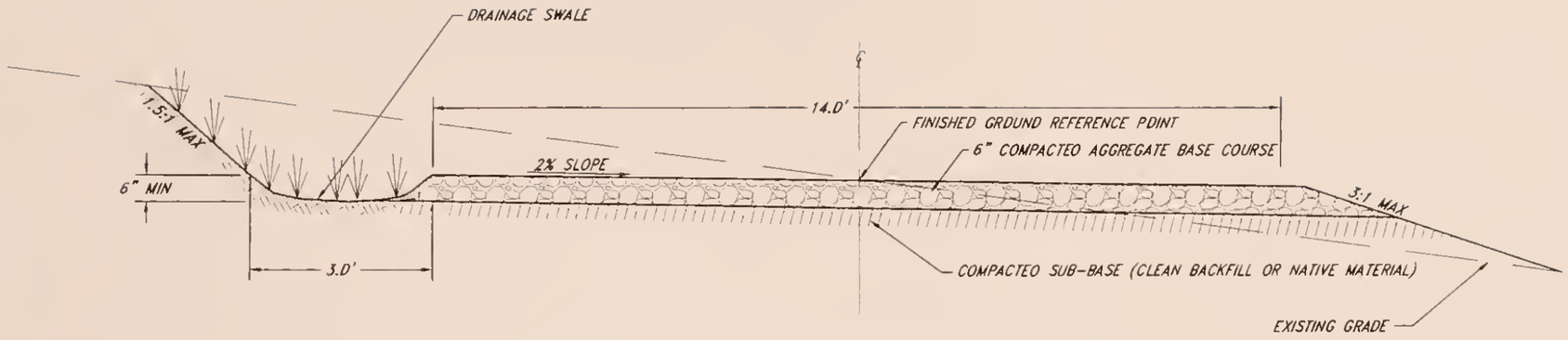
SCALE:
CONTOUR INTERVAL: 2'
SCALE IN FEET
0 50 100

NO	BY	DATE	REVISION DESCRIPTION

GSD IN COORDINATION WITH MDEQ
SSTOU, SUBAREA 1, SUBREACH A
SILVER BOW CREEK GREENWAY

GREENWAY TRAIL PROFILE
STA 59+00 TO 69+00

SHEET
P9



TRAIL BENCH ON SIDE SLOPE DETAIL (A/10)

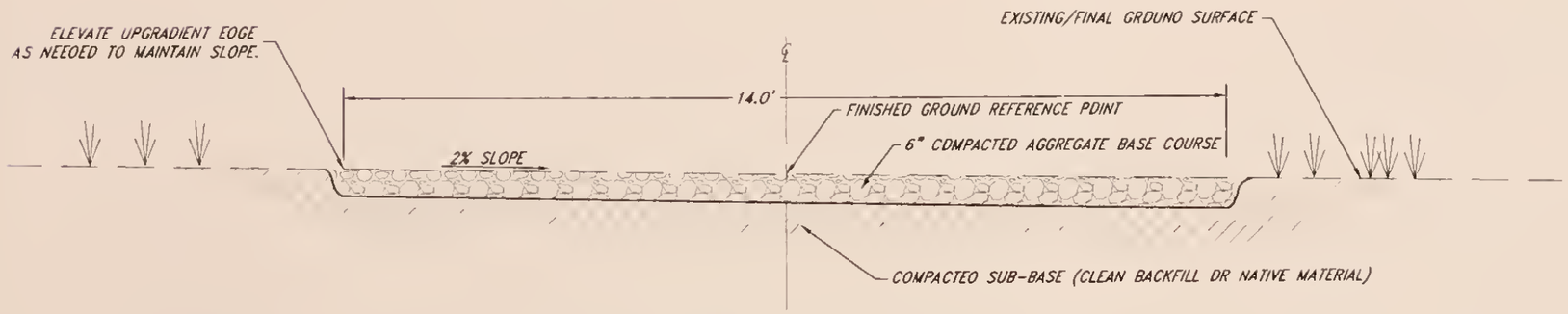
NOT TO SCALE

NOTES:

1. USE "ROAD TOP AGGREGATE" FOR COMPACTED AGGREGATE BASE COURSE LAYER (GRADE 1 CRUSHED AGGREGATE PER SECTION 820 OF THE TECHNICAL SPECIFICATIONS.)

2. PLACE, GRADE, AND COMPACT SUBGRADE AND BASE COURSE PER SECTION 820 OF THE TECHNICAL SPECIFICATIONS.

3. SEED SWALE, CUT SLOPE AND FILL SLOPE WITH APPROPRIATE SEED MIX CONSISTENT WITH THE REVEGETATION PLANS.


ELEVATE UPGRADIENT EOGE AS NEEOED TO MAINTAIN SLOPE.
EXISTING/FINAL GRDUNO SURFACE
14.0'
FINISHED GROUND REFERENCE PDINT
2% SLOPE
6" COMPACTED AGGREGATE BASE COURSE
COMPACTEO SUB-BASE (CLEAN BACKFILL DR NATIVE MATERIAL)

PRIMARY TRAIL BENCH DETAIL (B/10)

NDT TD SCALE

PIONEER TECHNICAL SERVICES, INC.
P.O. BOX 3446
BUTTE, MT 59702

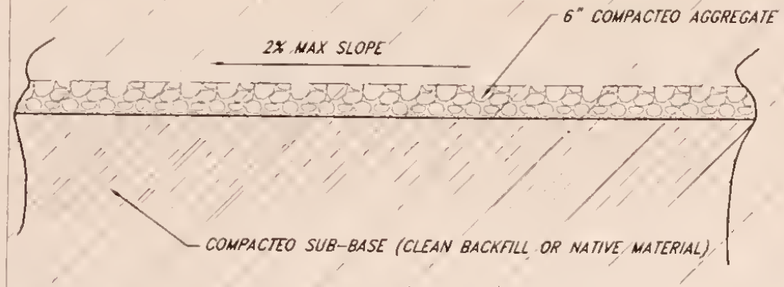
LJT DRAWN | JLG DESIGNED | TWH CHECKED
JLG APPROVED | 1/8/99 DATE | 8017-11 PROJECT NO.
SCALE: CONTOUR INTERVAL: NA
SCALE IN FEET 0 NA NA

NO.	BY	DATE	REVISION DESCRIPTION

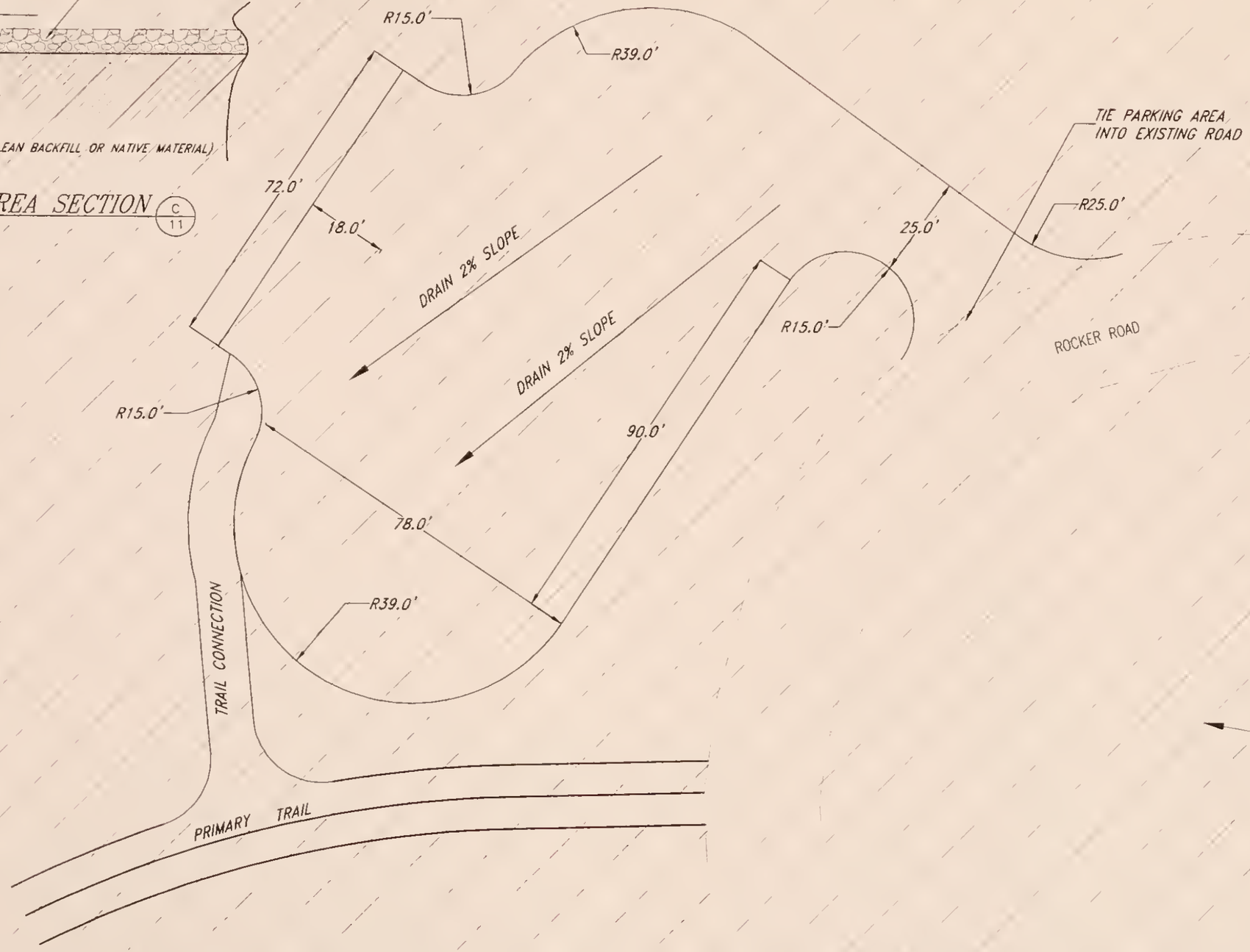
GSD IN COORDINATION WITH MDEQ
SSTOU, SUBAREA 1, SUBREACH A
SILVER BOW CREEK GREENWAY

TYPICAL GREENWAY TRAIL DETAILS

SHEET P10



TRAIL HEAD PARKING AREA SECTION (C/11)
N.T.S.



TRAIL HEAD PARKING AREA

PIONEER TECHNICAL SERVICES, INC.
P.O. BOX 3445
BUTTE, MT 59702

LJT	J.C.	TWH
DRAWN	DESIGNED	CHECKED
J.C.	6/8/99	8017-11
APPROVED	DATE	PROJECT NO.

SCALE
CONTOUR INTERVAL: NA
SCALE IN FEET
0 15 30

NO.	BY	DATE	REVISION DESCRIPTION

GSD IN COORDINATION WITH MDEQ
SSTOU, SUBAREA 1, SUBREACH A
SILVER BOW CREEK GREENWAY

WHISKEY GULCH STATION PLAN

SHEET
P11

Project: reacha
Horizontal Alignment Station and Curve Report
Alignment: tr-prim Desc: primary trail CL
Mon Jan 11 14:38:55 1999

Desc	Station	Spiral/Curve Data			Northing	Easting
		Tangent Data				
	11+03.42				743257.0775	1220740.7450
	11+95.06				743341.7103	1220705.5784
	Length:	91.65	Course:	N 22-33-50 W		
		Circular Curve Data				
PC	11+95.06				743341.7103	1220705.5784
RP					743226.5963	1220428.5427
PT	12+28.46				743317.7703	1220691.0775
	Delta:	06-22-39	Type:	LEFT		
	Radius:	300.00	DOC:	19-05-55		
	Length:	33.39	Tangent:	16.71		
	Mid-Ord:	0.46	External:	0.47		
	Chord:	33.37	Course:	N 25-45-09 W		
	Es:	0.47				
PI	15+03.82				743612.7443	1220557.8260
	Length:	55.36	Course:	S 65-17-01 W		
	Delta:	85-46-30				
		Tangent Data				
	12+28.46				743317.7703	1220691.0775
	13+64.49				743490.8163	1220625.2486
	Length:	136.03	Course:	N 28-56-29 W		
		Circular Curve Data				
PC	13+64.49				743490.8163	1220625.2486
RP					743418.2293	1220493.9812
PI	15+89.05				743554.4877	1220431.2622
	Delta:	85-46-30	Type:	LEFT		
	Radius:	150.00	DOC:	38-11-50		
	Length:	224.56	Tangent:	139.33		
	Mid-Ord:	40.10	External:	54.72		
	Chord:	204.17	Course:	N 71-49-44 W		
	Es:	54.72				
PI	20+03.33				743381.2650	1220054.9323
	Length:	310.41	Course:	N 53-36-46 W		
	Delta:	61-06-13				
		Tangent Data				
	15+89.05				743554.4877	1220431.2622
	18+26.25				743455.3065	1220215.7890
	Length:	237.20	Course:	S 65-17-01 W		
		Circular Curve Data				
PC	18+26.25				743455.3065	1220215.7890
RP					743727.8231	1220090.3510
PT	21+46.19				743486.3154	1219912.3790
	Delta:	61-06-13	Type:	RIGHT		
	Radius:	300.00	DOC:	19-05-55		
	Length:	319.94	Tangent:	177.08		
	Mid-Ord:	41.65	External:	48.36		
	Chord:	304.99	Course:	N 84-09-52 W		
	Es:	48.36				
PI	22+79.52				743565.4115	1219805.0457
	Length:	256.83	Course:	N 84-22-32 W		
	Delta:	30-45-47				
		Tangent Data				
	21+46.19				743486.3154	1219912.3790
	21+96.99				743516.4518	1219871.4840
	Length:	50.80	Course:	N 53-36-46 W		
		Circular Curve Data				
PC	21+96.99				743516.4518	1219871.4840
RP					743274.9441	1219693.5120
PT	23+58.07				743573.4998	1219722.9136
	Delta:	30-45-47	Type:	LEFT		
	Radius:	300.00	DOC:	19-05-55		
	Length:	161.07	Tangent:	82.53		
	Mid-Ord:	10.75	External:	11.14		
	Chord:	159.15	Course:	N 68-59-39 W		
	Es:	11.14				
PI	25+32.36				743590.5820	1219549.4542
	Length:	237.39	Course:	N 44-13-24 W		
	Delta:	40-09-08				
		Tangent Data				
	23+58.07				743573.4998	1219722.9136
	24+04.45				743578.0455	1219676.7551
	Length:	46.38	Course:	N 84-22-32 W		
		Circular Curve Data				
PC	24+04.45				743578.0455	1219676.7551
RP					743926.3606	1219711.0570
PT	26+49.72				743682.2505	1219460.2378
	Delta:	40-09-08	Type:	RIGHT		
	Radius:	350.00	DOC:	16-22-13		
	Length:	245.28	Tangent:	127.92		
	Mid-Ord:	21.27	External:	22.64		
	Chord:	240.29	Course:	N 64-17-58 W		
	Es:	22.64				
PI	27+59.19				743760.6990	1219383.8877
	Length:	272.40	Course:	N 80-27-21 W		
	Delta:	36-13-57				
		Tangent Data				
	26+49.72				743682.2505	1219460.2378
	26+77.40				743702.0854	1219440.9334
	Length:	27.68	Course:	N 44-13-24 W		
		Circular Curve Data				
PC	26+77.40				743702.0854	1219440.9334
RP					743527.7211	1219261.7768
PT	28+35.50				743774.2606	1219303.2289
	Delta:	36-13-57	Type:	LEFT		
	Radius:	250.00	DOC:	22-55-06		
	Length:	158.09	Tangent:	81.79		
	Mid-Ord:	12.79	External:	13.04		
	Chord:	155.47	Course:	N 62-20-23 W		
	Es:	13.04				
PI	30+26.10				743805.8650	1219115.2587
	Length:	295.82	Course:	N 45-01-48 W		
	Delta:	61-06-13				
		Tangent Data				
	28+35.50				743774.2606	1219303.2289
	29+14.32				743787.3300	1219225.4973
	Length:	78.82	Course:	N 90-27-21 W		

Project: reacha
Horizontal Alignment Station and Curve Report
Alignment: tr-prim Desc: primary trail CL
Mon Jan 11 14:38:55 1999

Desc	Station	Spiral/Curve Data			Northing	Easting
		Circular Curve Data				
PC	29+14.32				743787.3300	1219225.4973
RP					744132.4854	1219283.5301
PT	31+30.72				743884.8681	1219036.1727
	Delta:	35-25-33	Type:	RIGHT		
	Radius:	350.00	DOC:	16-22-13		
	Length:	216.40	Tangent:	111.79		
	Mid-Ord:	16.59	External:	17.42		
	Chord:	212.97	Course:	N 62-44-35 W		
	Es:	17.42				
PI	33+14.76				744014.9328	1218905.9714
	Length:	40.367	Course:	N 59-03-48 W		
	Delta:	14-02-00				
		Tangent Data				
	31+30.72				743884.8681	1219036.1727
	32+47.06				743967.0916	1218953.8629
	Length:	116.34	Course:	N 45-01-48 W		
		Circular Curve Data				
PC	32+47.06				743967.0916	1218953.8629
RP					743577.5788	1218565.1583
PT	33+81.77				744049.7333	1218847.9085
	Delta:	14-02-00	Type:	LEFT		
	Radius:	550.00	DOC:	10-25-03		
	Length:	134.71	Tangent:	67.69		
	Mid-Ord:	4.12	External:	4.15		
	Chord:	134.37	Course:	N 52-02-48 W		
	Es:	4.15				
PI	37+17.75				744222.4565	1218559.7285
	Length:	183.72	Course:	S 78-36-03 W		
	Delta:	42-20-09				
		Tangent Data				
	33+81.77				744049.7333	1218847.9085
	36+20.94				744172.6886	1218642.7637
	Length:	239.17	Course:	N 59-03-48 W		
		Circular Curve Data				
PC	36+20.94				744172.6886	1218642.7637
RP					743958.2547	1218514.2409
PT	38+05.67				744203.3233	1218464.8307
	Delta:	42-20-09	Type:	LEFT		
	Radius:	250.00	DOC:	22-55-06		
	Length:	184.72	Tangent:	96.81		
	Mid-Ord:	16.87	External:	18.09		
	Chord:	180.55	Course:	N 80-13-52 W		
	Es:	18.09				
PI	38+92.59				744186.1449	1218379.6280
	Length:	148.14	Course:	S 88-39-10 W		
	Delta:	10-03-09				
		Tangent Data				
	38+05.67				744203.3233	1218464.8307
	38+70.60				744190.4906	1218401.1819
	Length:	64.93	Course:	S 78-36-03 W		
		Circular Curve Data				
PC	38+70.60				744190.4906	1218401.1819
RP					744435.5592	1218351.7716
PT	39+14.46				744185.6283	1218357.6464
	Delta:	10-03-09	Type:	RIGHT		
	Radius:	250.00	DOC:	22-55-06		
	Length:	43.86	Tangent:	21.99		
	Mid-Ord:	0.96	External:	0.97		
	Chord:	43.81	Course:	S 83-37-38 W		
	Es:	0.97				
PI	40+40.62				744182.6637	1218231.5232
	Length:	251.50	Course:	S 63-21-24 W		
	Delta:	25-17-49				
		Tangent Data				
	39+14.46				744185.6283	1218357.6464
	39+84.51				744183.9821	1218287.6133
	Length:	70.05	Course:	S 88-39-13 W		
		Circular Curve Data				
PC	39+84.51				744183.9821	1218287.6133
RP					743934.0511	1218293.4881
PT	40+94.89				744157.5048	1218181.3791
	Delta:	25-17-49	Type:	LEFT		
	Radius:	250.00	DOC:	22-55-06		
	Length:	110.38	Tangent:	56.10		
	Mid-Ord:	6.07	External:	6.22		
	Chord:	109.48	Course:	S 76-00-18 W		
	Es:	6.22				
PI	42+90.28				744069.8834	1218006.7335
	Length:	417.73	Course:	N 57-04-25 W		
	Delta:	59-34-11				
		Tangent Data				
	40+94.89				744157.5048	1218181.3791
	42+27.33				744098.1166	1218063.0074
	Length:	132.43	Course:	S 63-21-24 W		
		Circular Curve Data				
PC	42+27.33				744098.1166	1218063.0074
RP					744196.4362	1218013.6794
PT	43+41.69				744104.1056	1217953.8876
	Delta:	59-34-11	Type:	RIGHT		
	Radius:	110.00	DOC:	52-05-13		
	Length:	114.37	Tangent:	62.96		
	Mid-Ord:	14.53	External:	16.74		
	Chord:	109.28	Course:	N 86-51-30 W		
	Es:	16.74				
PI	46+96.46				744296.9446	1217656.1055
	Length:	201.62	Course:	N 80-14-55 W		
	Delta:	23-10-30				
		Tangent Data				
	43+41.69				744104.1056	1217953.8876
	46+34.95				744293.5686	1217767.3974
	Length:	293.26	Course:	N 57-04-25 W		

Project: reacha
Horizontal Alignment Station and Curve Report
Alignment: tr-prim Desc: primary trail CL
Mon Jan 11 14:38:55 1999

Desc	Station	Spiral/Curve Data			Northing	Easting
		Circular Curve Data				
PC	46+34.95				744263.5086	1217707.7374
RP					744011.6979	1217544.6688
PT	47+56.29				744307.3633	1217595.4815
	Delta:	23-10-30	Type:	LEFT		
	Radius:	300.00	DOC:	19-05-55		
	Length:	121.34	Tangent:	61.51		
	Mid-Ord:	6.11	External:	6.24		
	Chord:	120.52	Course:	N 68-39-40 W		
	Es:	6.24				
PI	48+96.40				744331.0947	1217457.3949
	Length:	426.59	Course:	N 71-15-58 W		
	Delta:	8-58-57				
		Tangent Data				
	47+56.29				744307.3633	1217595.4815
	48+37.49				744321.1167	1217515.4547
	Length:	81.20	Course:	N 80-14-55 W		
		Circular Curve Data				
PC	48+37.49				744321.1167	1217515.4547
RP					745060.2803	1217642.4865
PT	49+55.07				744350.0155	1217401.6050
	Delta:	08-58-57	Type:	RIGHT		
	Radius:	750.00	DOC:	07-38-22		
	Length:	117.58	Tangent:	58.91		
	Mid-Ord:	2.30	External:	2.31		
	Chord:	117.46	Course:	N 75-45-26 W		
	Es:	2.31				
PI	53+22.75				744468.1058	1217053.4031
	Length:	315.31	Course:	S 66-38-13 W		
	Delta:	42-05-50				
		Tangent Data				
	49+55.07				744350.0155	1217401.6050
	51+59.20				744415.5757	1217208.2937
	Length:	204.13	Course:	N 71-15-58 W		
		Circular Curve Data				
PC	51+59.20				744415.5757	1217208.2937
RP					744013.0924	1217071.7942
PT	54+71.46				744403.2466	1216903.2572
	Delta:	42-05-50	Type:	LEFT		
	Radius:	425.00	DOC:	13-28-53		
	Length:	312.26	Tangent:	163.56		
	Mid-Ord:	28.36	External:	30.39		
	Chord:	305.29	Course:	S 87-41-08 W		
	Es:	30.39				
PI	58+23.21				744263.7560	1216580.3437
	Length:	618.83	Course:	N 58-18-44 W		
	Delta:	55-03-03				
		Tangent Data				
	54+71.46				744403.2466	1216903.2572
	55+75.68				744361.9188	1216807.5856
	Length:	104.22	Course:	S 66-38-13 W		
		Circular Curve Data				
PC	55+75.68				744361.9188	1216807.5856
RP					744797.9735	1216619.2208
PT	63+32.07				744393.7848	1216369.7083
	Delta:	55-03-03	Type:	RIGHT		
	Radius:	475.00	DOC:	12-03-44		
	Length:	456.39	Tangent:	247.54		
	Mid-Ord:	53.77	External:	60.63		
	Chord:	439.04	Course:	N 85-50-16 W		
	Es:	60.63				
PI	64+03.36				744588.8214	1216053.7660
	Length:	452.72	Course:	N 89-31-37 W		
	Delta:	31-12-53				
		Tangent Data				
	60+32.07				744393.7848	1216369.7083
	63+96.08				744427.4117	1216315.2356
	Length:	64.02	Course:	N 58-18-44 W		
		Circular Curve Data				
PC	60+96.08				744427.4117	1216315.2356
RP					743491.3959	1215737.4170
PT	65+95.36				744591.3584	1215746.4991
	Delta:	31-12-53	Type:	LEFT		
	Radius:	1100.00	DOC:	05-12-31		
	Length:	599.28	Tangent:	307.28		
	Mid-Ord:	40.56	External:	42.11		
	Chord:	591.89	Course:	N 73-55-11 W		
	Es:	42.11				
PI	68+40.81				744592.5592	1215601.0576
	Length:	368.52	Course:	N 61-40-14 W		
	Delta:	27-51-23				
		Tangent Data				
	66+95.36				744591.3584	1215746.4991
	67+78.81				744592.0473	1215663.0549
	Length:	83.45	Course:	N 89-31-37 W		
		Circular Curve Data				
PC	67+78.81				744592.0473	1215663.0549
RP					744820.0388	1215665.3190
PT	69+00.35				744621.9806	1215546.4836
	Delta:	27-51-23	Type:	RIGHT		
	Radius:	250.00	DOC:	22-55-06		
	Length:	121.55	Tangent:	62.00		
	Mid-Ord:	7.35	External:	7.57		
	Chord:	120.35	Course:	N 75-35-55 W		
	Es:	7.57				

PIONEER TECHNICAL SERVICES, INC.
P.O. BOX 3445
BUTTE, MT 59702

LJT	JLG	TMH
DRAWN	DESIGNED	CHECKED
JLG	6/8/99	8017-11
APPROVED	DATE	PROJECT NO.

SCALE:
CONTOUR INTERVAL: NA
SCALE IN FEET
0 15 30

NO.	BY	DATE	REVISION DESCRIPTION

GSD IN COORDINATION WITH MDEQ
SSTOU, SUBAREA 1, SUBREACH A
SILVER BOW CREEK GREENWAY

HORIZONTAL AND VERTICAL
ALIGNMENT DATA

SHEET
P12

APPENDIX A

APPENDIX A

SPECIAL PROVISIONS AND TECHNICAL SPECIFICATIONS

Final Design Report - Reach A Subarea 1
Streamside Tailings Operable Unit
Remedial Design

APPENDIX A-1

Special Provisions

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SECTION III
SPECIAL PROVISIONS

This section of the Contract Documents describes the project and details the work required as shown on the construction drawings. The Technical Specifications for each component of the project are referenced and the method of measurement and payment is identified. Any Special Conditions applicable to this project are also identified. Any subsequent addenda issued after these documents have been prepared shall supplement and/or supersede any article of the Specifications. For any discrepancies between the Special Provisions and the Technical Specifications, the Special Provisions will govern. In all documents for this project, the terms "Owner's Representative" and "Engineer" are synonymous.

1. PROJECT DESCRIPTION

A pre-bid conference is scheduled. The date and time for this conference are found in Section I, 1.1 Invitation For Bid, Subsection Pre-Bid Conference on Page IFB-4. The contract time for this bid package is found in Section I, 1.1 Invitation For Bid, Subsection Contract Time on Page IFB-4.

Silver Bow Creek has been contaminated by mine wastes for its entire length from Butte to the Warm Springs Ponds. This contract initiates remedial activities for approximately the first 1¼ mile segment of this stream. The entire Operable Unit consists of the stream, its banks and floodplain, railroad beds and embankments adjacent to the floodplain, and all other areas in close proximity to the floodplain that are necessary for implementation of the remedial action. Contaminants of concern are the inorganic elements arsenic (As), cadmium (Cd), copper (Cu), lead (Pb), mercury (Hg), and zinc (Zn). Table III-1 summarizes the concentrations of the contaminants of concern for the primary media at the site. These contaminants are found in the instream sediments, the tailings materials and associated soils found in the streambanks and floodplain, and some railroad materials. Much of the contaminated material located in the stream channel or the floodplain is saturated with water throughout the year.

Table III-1
Typical Concentrations of Contaminants of Concern
Streamside Tailings Operable Unit

Medium	Arsenic (mg/Kg)	Cadmium (mg/Kg)	Copper (mg/Kg)	Lead (mg/Kg)	Mercury (mg/Kg)	Zinc (mg/Kg)
Tailings/ Impacted Soils[1]	278	7.8	739	540	2.1	2,400
Instream Sediments[2]	70.7	4.4	816	234	0.55	1,244
Railroad Materials[3]	375	2.0	1,081	587	NS[4]	687

Notes:

[1] Median concentration in tailings/impacted soils from Subarea 1 from Table 4-4 of draft *Remedial Investigation Report, Silver Bow Creek/Butte Area NPL Site, Streamside Tailings Operable Unit RI/FS* (ARCO, 1995).

[2] Geometric mean concentration in sediments from Subarea 1 from Table 4-22 of draft *Remedial Investigation Report, Silver Bow Creek/Butte Area NPL Site, Streamside Tailings Operable Unit RI/FS* (ARCO, 1995).

[3] Median concentration in waste rock from Streamside Tailings Operable Unit from Table 4-2 of draft *Remedial Investigation Report, Silver Bow Creek/Butte Area NPL Site, Streamside Tailings Operable Unit RI/FS* (ARCO, 1995).

[4] NS - Not Sampled.

Further information on the Streamside Tailings Operable Unit and the design process for Reach A can be found in the following documents:

- **Atlantic Richfield Company, 1995.** Draft Remedial Investigation Report, Silver Bow Creek/Butte Area NPL Site, Streamside Tailings Operable Unit RI/FS.

- **Atlantic Richfield Company, 1995.** Draft Feasibility Report, Silver Bow Creek/Butte Area NPL Site, Streamside Tailings Operable Unit RI/FS.

- **Atlantic Richfield Company, 1997.** Intermediate Design Report, Subarea 1, Silver Bow Creek/Butte Area NPL Site, Streamside Tailings Operable Unit RI/FS.

- **Maxim Technologies, Inc., 1998.** Construction Quality Assurance Plan, Remedial Action, Subarea 1 - Reach A, Streamside Tailings Operable Unit, Silver Bow Creek/Butte Area NPL Site.

- **Maxim Technologies, Inc., 1999.** Final Design Report, Remedial Action, Subarea 1 - Reach A, Streamside Tailings Operable Unit, Silver Bow Creek/Butte Area NPL Site.

- **Montana Department of Environmental Quality and U.S. Environmental Protection Agency, 1995.** Record of Decision, Streamside Tailings Operable Unit of the Silver Bow Creek/Butte Area National Priorities List Site.

- **Montana Department of Environmental Quality and U. S. Environmental Protection Agency, 1998.** Explanation of Significant Differences, Streamside Tailings Operable Unit, Silver Bow Creek/Butte Area (Original Portion) National Priorities Site.

Copies of these reports are available for a fee directly from Insty Prints in Helena, MT (406) 449-7860. Additional copies of these reports are available for review at the following information repositories:

Anaconda: Hearst Free Library, 4th & Main

Bozeman: MSU Renne Library, MSU Campus Complex

Butte: Butte Public Library, 226 E. Broadway
Montana Tech Library, ELC Building, 1300 W. Park St.
EPA Office, 155 W. Granite
CTEC Office, 156 W. Granite

Deer Lodge: Grant-Kohrs Ranch NHS

Helena: EPA, Federal Building, 301 S. Park Ave.
DEQ, 2209 Phoenix Ave.
State Library, 1515 East 6th Ave.

Missoula: Missoula County Library, 301 E. Main
UM Mansfield Library, UM Campus Complex
Clark Fork-Pend Oreille Coalition, 102 E. Main

The project is located along approximately one and one quarter mile of Silver Bow Creek, starting at the westbound bridge of Interstate 90/15, just west of Butte, Montana in Silver Bow County. The work under this contract consists of excavating tailings/impacted soils and in-stream sediments from a portion of Silver Bow Creek and its floodplain, transporting and placing tailings and sediments in Mine Waste Relocation Repository 2 (MWRR 2), constructing a reconstructed channel and streambanks, and backfilling the floodplain with material from a designated borrow area. The borrow area will be excavated to specified final topography and prepared for revegetation. The work includes the construction of a diversion channel for stream dewatering and the construction of a system of trenches, sumps, and sediment basins for groundwater dewatering in the floodplain. Tailings and sediments will be treated with a lime amendment before final compaction in MWRR 2. The MWRR 2 will be capped with a soil cover system. Mine waste materials in railroad embankments will be covered with rock material. Sediment basins will be constructed to trap runoff from mine waste material embankments outside of the Operable Unit. Work includes the recontouring the floodplain to accommodate construction of the Greenway trail base. Seeding of the streambanks is required as part of this project. All other revegetation will be accomplished under a separate contract.

It is expected that construction will require two seasons and a winter shut-down period will be required. No separate payment will be made for winter-shut-down. All winter shut-down costs should be included in the appropriate bid items.

The Contractor and all on-site personnel under the Contractor's supervision shall comply with all Occupational Safety and Health Administration (OSHA) Regulations including 29 CFR 1910.120, the 40-Hour Health and Safety Training for Hazardous Waste Operations and Emergency Response. All site workers shall have completed the 40-Hour course and be current with the annual 8-hour refresher course.

2. INSPECTION OF SITE AND PREBID CONFERENCE

In accordance with Article 3 of the Instructions to Bidders and Article 2 of the General Conditions, the Contractor shall satisfy him/herself as to the construction conditions by personal examination of the site of the proposed work and any other examination and investigation that he/she may desire to make as to the nature of the construction and the difficulties to be encountered. Contractor shall promptly report in writing to Owner's Representative any conflict, error or discrepancy which Contractor may discover and shall obtain a written interpretation from Owner's Representative before proceeding with the work.

Within twenty days after the effective date of the Agreement and before the Contractor starts work at the site in accordance with Paragraph 2.06 of the General Conditions a preconstruction conference between the Owner, Contractor, Owner's Representative, and others as appropriate, will be held to establish a working understanding among the parties as to the work. The purpose of the conference will be to discuss schedules, submittal procedures, applications for payment, and maintaining required records.

3. PROJECT RELATED CONTACTS

(a) General Information, Landowner Concerns, and Prebid Information:

Comments and questions about the meaning or intent of the Contract Documents are to be submitted in writing and addressed to the following contact:

Department of Environmental Quality
2209 Phoenix Avenue
P.O. Box 200901
Helena, MT 59620-0901
Fax: 406-444-0443
Contact: Joel Chavez 406-444-5440
Keith Large 406-444-5875
Tim Reilly 406-444-1428

(b) Construction Quality Assurance: Maxim Technologies, Inter-Fluve, and Pioneer Technical Services

(c) Utilities:

General	Utilities Underground Location Center Call Before You Dig (800) 424-5555
Power Poles and Overhead Electric Lines	Montana Power Company Contact: Dan Mahoney (406) 497-2181
Sewage Sludge Line	Butte Silver-Bow Department of Public Works Metro Sewer Division Contact: Tom Piercy (406) 723-8262
Fiber Optic Cable and Overhead Telephone Lines	U.S. West Contact: John Johnston (406) 496-2685

Butte Water Lines	Butte Silver-Bow Department of Public Works Water Utility Division Contact: Dave Schultz (406) 782-9021
Silver Lake Pipeline	Butte Silver-Bow Department of Public Works Water Utility Division Contact: Dave Schultz (406) 782-9021
Rocker Water and Sewer Lines	Rocker Water and Sewer District Contact: Albert Molignoni (406) 723-9365

4. POLLUTION PREVENTION LIABILITY INSURANCE

The Contractor shall provide such Pollution Prevention Liability Insurance as is set forth in the Supplementary Conditions. The Contractor's cost to obtain the required Pollution Prevention Liability Insurance shall be included in the pay item for Mobilization, Bonding, and Insurance.

5. HEALTH AND SAFETY PLAN

The Contractor will be required to submit a site specific Health and Safety Plan. The plan shall be written in accordance with the following U.S. Department of Labor Occupational Safety and Health Administration (OSHA) standard practices: Safety and Health Standards 29 CFR 1926 (General Industry), OSHA 29 CFR 1910.120 Hazardous Waste Operations and Emergency Response, Safety and Health Standards 29 CFR 1926 (Construction Industry), and Occupational Safety and Health Guidance manual for Hazardous Waste Site Activities (U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health (NIOSH). At a minimum, the plan shall address the following elements: staff organization, responsibilities, and authorities; site description; hazard analysis for each project task and operation; general and site-specific training; personal protection equipment; medical surveillance; personal and environmental exposure monitoring including air monitoring for on-site workers; standard operating safety procedures, engineering controls, and work practices; communications; illumination; site control measures; personnel hygiene and decontamination; equipment decontamination; emergency equipment and first aid; emergency response and contingency procedures; and logs, reports, and record keeping. A particular concern on this project is the handling of lime amendment which is severely caustic. The Contractor shall also be required to coordinate with the Rarus Railway safety officer on railroad safety issues. The Health and Safety Plan shall be submitted in accordance with Section 20 of these Special Provisions.

Of particular concern with the construction activities described in these Special Provisions is the potential for worker exposure to airborne substances that may pose a threat to human health. The Contractor's Health and Safety Plan shall contain a detailed description of the personal air monitoring and sampling which the Contractor shall conduct during construction activities in accordance with OSHA requirements.

6. EROSION CONTROL PLAN

The Contractor will be required to submit an Erosion Control Plan for the construction activities within Reach A. The plan shall be written in accordance with the Montana Department of Environmental Quality *Montana Sediment and Erosion Control Manual, May 1996*, and the U.S. Environmental Protection Agency's *Storm Water Management for Construction Activities; Developing Pollution Prevention Plans and Best Management Practices, September, 1992*. A general plan titled *MPDES Storm Water Erosion Control Plan for Remedial Construction Activities, Streamside Tailings Operable Unit, Silver Bow Creek* has been prepared to identify the general types of work and the types of Best Management Practices (BMP's) anticipated for the entire operable unit. This general plan is included as Appendix A to these Special Provisions. For this contract, the Contractor is expected to prepare a site-specific erosion control plan which details locations and types of BMP's to be used during this project's construction activities. Any mulching used for erosion control shall be in accordance with Technical Specification Subsection 330.00, Mulch. The type of mulch, manufacturer's specifications, material content and recommended application methods and rates shall be specified in the

Erosion Control Plan. The Erosion Control Plan is to be submitted in accordance with Section 20 of these Special Provisions.

7. QUALITY CONTROL/QUALITY ASSURANCE

Quality control will be the responsibility of the Contractor in order to assure that construction complies with the requirements of the contract plans, special provisions, and specifications. The Owner will be responsible for quality assurance in the form of construction oversight to check that the Contractor is performing adequate construction and quality control.

The Contractor will be required to submit a Contractor Quality Control Plan for this contract. The plan shall be in accordance with Technical Specification Subsection 140.00, Contractor Quality Control. Technical Specification Subsection 140.00 identifies all of the requirements for quality control by the Contractor. Specific Contractor quality control testing, sampling, and analyses requirements are described for each work item in Section 8 of these Special Provisions. The Contractor Quality Control Plan shall be submitted according to Section 20 of these Special Provisions.

Quality assurance responsibilities are detailed in the *Construction Quality Assurance Plan* (CQAP). The Owner's Representative will be responsible for the requirements of the CQAP. A copy of the CQAP is available upon request.

8. WORK DESCRIPTION

(A) **General:** The construction site included in this project includes saturated fine-grained tailings materials and impacted soils. Dewatering of the tailings/impacted soils is considered necessary to accomplish the work. The Contractor is required to provide equipment and methods necessary to mix lime with tailings/impacted soils at MWRR 2. Conventional construction techniques and equipment may not be appropriate for this project and the Contractor should consider these factors when preparing the bid and planning and scheduling the project (see the attached Section II, 2.2 Contractor Personnel and Proposed Project Approach). The Contractor will be the sole authority for the means and methods necessary to complete the work as specified and described in this document.

The Contractor assumes full and sole responsibility for the capability of selected construction techniques to complete the work in accordance with this document. The Contractor also assumes full and sole responsibility for safety and environmental protection with the selected construction techniques. Review of submittals by the Owner in no way relieves the Contractor of these responsibilities.

All solid or liquid wastes generated by construction activities shall be contained and stored in a neat and orderly manner. Liquid wastes, which may include, but are not limited to, grease, used motor oil, and sanitary waste shall be disposed of off-site. All wastes shall be stored and handled in accordance with Montana Department of Environmental Quality regulations. Solid wastes, other than mine waste, shall be contained in a single location and prevented from being blown around by wind. All solid wastes shall be removed from the site upon completion of this project and disposed of at a licensed landfill.

To prevent the spread of noxious weeds into the project area, construction equipment must be cleaned with high pressure water before moving equipment into the project area. Equipment requiring cleaning includes: wheels, tracks, undercarriages, fenders, blades and buckets.

(B) **Permits:** Permits may be needed and it is the Contractor's responsibility to obtain any required permits for the work. The cost to secure permits shall be considered incidental to the work, including permit requirements for maintenance, record keeping, and reporting. Copies of all permits shall be submitted to the Owner's Representative prior to initiating construction activities.

(C) **Staging Area:** An equipment and materials staging area shall be constructed in the location designated on Sheet M3 of the Drawings. Any additional space needed or modifications to the boundaries indicated on the Drawings shall be subject to approval by the Owner's Representative. The Contractor shall limit equipment and materials storage to the staging area, unless specifically approved by the Owner's Representative. The Contractor will be responsible for security of the staging area, hazardous material containment and clean up (for all materials including motor oil, hydraulic and transmission fluid, anti-

freeze, brake fluid, and all other materials and chemicals used in the maintenance of equipment and machinery), weed control, and drainage and erosion control. The Contractor shall regrade the area to approximate original topography after the completion of work. Revegetation will be performed under a separate contract.

(D) **Construction Office Facilities:** The Contractor shall provide all necessary office and material testing trailers or buildings, including the Owner's Representative's Field Office. The Owner's Representative's Field Office is described in Technical Specification Subsection 510.00. The field office facilities shall include sanitary facilities, such as self-contained portable toilets, and wash areas.

(E) **Decontamination Area:** An equipment Decontamination Area shall be constructed for the project and the location shall be determined by the Contractor and approved by the Owner's Representative. It is suggested that the decontamination area be located near the staging area at the boundary of the tailings impacted floodplain where all decontamination procedures can be implemented. Equipment decontamination will consist of removing all visible tailings/impacted soil material from the outside of vehicles, including the wheels, tracks, undercarriages, fenders, blades, buckets, and the exterior body. Either dry or wet methods of decontamination will be acceptable.

To minimize the exposure of equipment to contaminants, all staging areas will be located in non-impacted areas (containing no floodplain tailings or railroad waste materials.) Vehicles used to travel in contaminated areas will be staged such that these vehicles do not leave a controlled area before decontamination. Equipment used to excavate and dispose of tailings in MWRR 2 will not be required to be decontaminated unless the equipment leaves the site to travel outside the operable unit. Any contaminated materials spilled outside the operable unit must be immediately removed and deposited in MWRR 2 by the Contractor.

Trucks hauling tailings/impacted soils will not be required to decontaminate on every run. This includes travel on both the primary haul roads and the county road. After completion of tailings/impacted soils hauling, trucks and equipment used in handling of the tailings/impacted soils shall be decontaminated prior to leaving the operable unit.

(F) **Clearing and Grubbing:** Clearing and grubbing of the site will be required for all areas that will be disturbed. Clearing and grubbing shall include removing all vegetation, woody shrubs and root balls from the designated borrow area, sediment basins, MWRR 2, haul roads, and tailings excavation areas as shown on the drawings. All woody materials shall be cut no higher than six inches above the surface and the woody stems chipped or shredded and stockpiled for placement as mulch for another contract.

Clearing and grubbing shall also include stripping sod from the tailings/impacted soil excavation area. Stripping depth shall be a maximum of 2 inches and will include, to the extent practicable, only vegetative material. Stripped sod material shall be stockpiled separately and transported to MWRR 2 in accordance with the provisions described in the Special Provisions Section 8(J).

All clearing and grubbing shall be conducted in accordance with Technical Specification Subsection 201.00, except burning is not allowed and disposal of debris shall be in accordance with Special Provisions Section 8(G). For purposes of this work item, disregard any reference to Technical Specification Subsection 502.00 in Technical Specifications Subsection 201.00. "Clearing limits" and "grubbing limits" as mentioned in Technical Specification Subsection 201.00 are synonymous with "Disturbance Limits" or "Limits of Disturbance" as shown on the Drawings.

(G) **Debris Disposal:** Debris, which is not regulated hazardous waste, recovered during clearing, grubbing, stripping, and excavation activities shall be salvaged or disposed at either a permitted Class II, Class III or Class IV landfill, depending on the type of debris. Classes of landfills are defined in the Montana Solid Waste Management regulations under the Administrative Rules of Montana (ARM) 17.50.503 and 504. All non-hazardous debris anticipated to be encountered at the project site will be accepted at a Class II facility. Class III facilities will accept inert wastes only. The Owner's Representative will determine if debris is to be salvaged. At no time will onsite burning or burial of debris be allowed. Debris shall be defined as, but not limited to, vegetation and the remains of any manmade objects found within the project disturbance limits. Prior to disposal, all debris must be separated into the categories and disposed at the appropriate disposal facility in like loads.

Prior to disposal the following provisions apply:

- Large scrap items shall be reduced to appropriate size that is accepted by the solid waste disposal facility;
- Mixed commercial materials will be crushed;
- Dislodge gross soil mass from treated and untreated timbers, stumps, and root balls;
- Remove the majority of soil from mixed commercial waste and demolition debris by either mechanical or manual means so that less than five (5) percent of any load transported to the landfill consists of soil; and
- Loads must be covered prior to transport.

(H) **Haul Roads and Traffic Control:** Haul roads are required to be constructed across Reach A and portions of Reaches B and C in the general locations shown on Sheet M11 of the Drawings. Haul roads will run from the eastern, or upstream, portion of Reach A to Borrow Area (BA) 10 located approximately ¾ mile west of the town of Rocker. The haul roads will run from the Reach A floodplain to MWRR 2. Lumped together as one pay item are the following work items: preparation of a transportation plan; all primary and secondary haul road construction and maintenance; stream, diversion channel and utility crossings construction and maintenance; construction and maintenance of public road approaches and crossings; construction and maintenance of approaches for railroad crossings; and reclamation of haul roads in the area of Reach A which will not be used in future construction contracts. Traffic control is a separate pay item.

(1) **Transportation Plan:** The Contractor shall prepare a Transportation Plan for the project prior to construction of haul roads and crossings. The Transportation Plan shall be submitted as described in Special Provisions Section 20. The Transportation Plan shall be a comprehensive document addressing all transportation issues for this project and shall include, at a minimum, the following information:

- anticipated haul routes
- anticipated haul equipment
- a traffic control plan, including railroad crossings details
- proposed stream and diversion channel crossing locations
- proposed stream and diversion channel crossing designs
- a road maintenance plan, including country roads and private accesses
- a road dust control plan
- a lime hauling plan, including dust control for transport and placement
- a road reclamation plan.

The Owner shall coordinate with the State of Montana Department of Transportation and Butte-Silver Bow County for review and acceptance of the Transportation Plan.

(2) **Primary and Secondary Haul Road Construction:** The locations of the primary haul roads are shown on Sheet M11. Approximately 16,000 feet of primary haul roads are required for the project. The Contractor will have the responsibility to field locate the primary haul roads. The haul locations may deviate slightly from the locations indicated on Drawing Sheet M11, but the anticipated routes will be subject to approval by the Owner's Representative. The locations of the secondary haul roads are not shown on the Drawings and will be determined by the Contractor with approval by the Owner's Representative.

Design and construction of both primary and secondary haul roads will be the responsibility of the Contractor. When running parallel to railroad lines, the edge of the road running surface shall be at least 25 feet from the centerline of the tracks. All primary haul roads shall accommodate two-way traffic unless site conditions require single-width roads. If single-width roads are needed, the Contractor shall provide all needed traffic control. The stream crossings and railroad crossings will remain in place after the end of this contract, except for the railroad crossing near MWRR 2 which will be removed and reclaimed for this contract. The stream and railroad crossings are to remain static and their locations shall not change during the course of this contract. Included in this work will be the design and construction of public road crossings and approaches for railroad crossings. Public road and railroad approaches will be constructed to maximize vehicle visibility and stopping

distance. Signage and traffic control at public road and railroad crossings are covered under the Traffic Control Section 8(H)(6) of these Special Provisions.

Monitoring well C-15 (Drawing M4c) is located near Whisky Gulch in a position that may interfere with haul road construction. This monitoring well may be abandoned in accordance with Technical Specification 511.00 at the Contractor's discretion and at the Contractor's expense.
Haul roads shall be designed and constructed for the anticipated loads and sizes of trucks for hauling wastes and borrow materials. Soil test data for anticipated haul road locations is available for Contractor in Appendix B of these Special Provisions. The Contractor shall provide adequate drainage measures, including culverts at drainage crossings and road ditches. The locations of culverts are shown on the Drawings but it will be the responsibility of the Contractor to determine appropriate culvert sizes, subject to approval by the Owner's Representative. The Contractor shall provide all maintenance and dust control for the haul roads. Work also includes maintenance of the county road and private accesses to the county road.

The construction of the haul road access to MWRR 2 requires building an elevated road prism which will increase in elevation as the repository is built. It is anticipated that this portion of the haul road will be built in at least two sequences to accommodate the increasing elevation of the repository. Approximately 15,000 cubic yards of borrow material is available at the repository site as shown on drawing M9b for construction of this portion of the haul road.

Prior to construction of haul roads in all areas including areas of tailings/impacted soils, an area sufficient to construct the road cross-section shall be cleared and grubbed in accordance with Section 8(F), debris shall be removed in accordance with Section 8(G), and tailings/impacted soils shall be excavated and disposed in accordance with Section 8(J) of these Special Provisions. The base of tailings elevations at the stream crossing locations are shown on Drawing Sheet M5f.

(3) **Stream, Diversion Channel, Utility Crossings, and Railroad Approaches Construction:** Several utility, stream, railroad, and diversion channel crossings are required as part of the haul roads. Sheet M11 shows the specific locations for the crossings, except the location and number of diversion channel crossings will be determined by the Contractor and approved by the Owner's Representative. Utility crossings will be constructed in accordance with the appropriate utility requirements. Railroad crossings will be constructed by Rarus Railway, although the Contractor will be responsible for railroad crossing approaches.

Two specific locations are identified as stream crossings for the primary haul roads (Drawing Sheet M11). The crossings shall be designed and constructed by the Contractor. The designs and installation procedures shall be submitted as part of the Transportation Plan to the Owner's Representative for approval according to Special Provisions Section 20. The crossings shall be designed to remain in place for at least three years. The crossings shall be culvert or other flow conveyance installations in Silver Bow Creek. The flow structures shall be designed and sized to pass 200 cfs. The road approaches to the crossings shall be at or below existing floodplain surface grades to allow passage of flood flows with minimal backwater. The road fill over the flow structures shall be adequate to provide minimum cover requirements over the flow structures and maintain maximum road grades, but shall be designed as small as possible to create minimal flow obstruction to flood flows. The crossing shall include erosion protection for the flow structures and fill embankments. Maintenance of the flow structures shall be the responsibility of the Contractor for the duration of the contract. The flow structures shall remain in-place at the termination of the contract.

Construction of diversion channel crossings to access the floodplain from the primary haul roads is also part of this item and shall be accomplished in accordance with the design on Drawing Sheet I25. The number of diversion channel crossings is at the discretion of the Contractor. The diversion channel crossings shall only be in place during the time of construction activities. If winter shut-down is necessary, the crossings shall be entirely removed prior to the Contractor leaving the site. Once construction commences, if crossings are still required, they shall be reconstructed in accordance with the Drawings and Technical Specifications. The diversion channel crossings shall be permanently removed at the end of the construction contract. The integrity of the diversion

channel berms shall be maintained during construction and removal of the diversion channel crossings. Damaged areas shall be immediately repaired.

The utility crossings for the haul roads consist of measures to prevent damage to existing buried utilities. There are five types of buried utilities crossed by the planned haul roads: (1) the Silver Lake water line, (2) the water line for the Town of Rocker, (3) a natural gas line, (4) a telephone fiber optic line, and (5) a sewage sludge pipeline. The utility crossings are identified on Drawing Sheet M11. The Contractor shall design and install adequate structural measures to prevent damage to the utilities. The designs and installation procedures shall be submitted to the appropriate Utility and the Owner's Representative for approval at least 14 days prior to installation. The crossings shall be designed to remain in place for at least three years, except for the crossings for the road to MWRR 2 which will be removed and reclaimed under this contract. The Contractor shall coordinate with the appropriate utility representatives to determine locations and crossing requirements (see Special Provisions Section 3). It is anticipated that the Contractor will be required to locate the utilities at the exact crossing locations, determine their depths below the ground surface, obtain soil engineering properties of the overburden material, and conduct an engineering analysis to design an appropriate crossing structure.

Two railroad crossings will be constructed on the Butte, Anaconda, and Pacific (BA&P) line, which is operated by the Rarus Railway Company. The crossing locations are shown on Drawing Sheet M11. One crossing will be on the primary haul road leading to MWRR 2 and one will be on the primary haul road near Borrow Area 10 in the lower portion of Reach B. Rarus Railway Company will design and construct the two crossings under separate contract with the Owner. The Contractor shall design and construct the approaches to each of the two crossings under this contract. The Contractor shall coordinate with Rarus Railway on location and construction of the crossings.

(4) **Haul Road Maintenance:** The Contractor shall maintain and repair all haul roads and appurtenances as needed to facilitate the effective hauling of material. The Contractor shall immediately remove and haul to MWRR 2 any spilled tailings/impacted soil on uncontaminated areas. Tailings/impacted soil deposited on the constructed primary haul road by tracking shall be removed and hauled to MWRR 2 a minimum of once every week or more frequently at the request of the Owner's Representative. The Contractor shall exercise particular care at stream crossing to ensure that tailings/impacted soils are not spilled in the stream.

(5) **Haul Road Reclamation**: Haul roads and crossings constructed in Reach A and accessing MWRR 2 will be reclaimed after completion of the work for Reach A. All spilled tailings/impacted soil shall be removed and hauled to MWRR 2. Haul roads shall be regraded to the original ground topography and the stockpiled topsoil from the haul road areas shall be replaced. Revegetation of the haul road is to be accomplished under a separate contract. The haul roads from Reach A to Borrow Area 10 will remain after completion of this contract. Public road and railroad crossings will be secured to prevent public access during non-construction seasons.

(6) **Traffic Control:** Haul routes and traffic controls will be appropriate to the type and size of haul equipment used. It is anticipated large off-road trucks, scrapers, and excavation equipment will be used during construction activities. Right-of-ways will be established and signs and flagpersons will be used along public roads at haul road intersections and entrances/exits as well as along haul road routes to maintain traffic flow and safety.

Traffic control shall be performed in compliance with Montana Department of Transportation Traffic Control Regulations, the requirements of the State or Silver Bow County, and Technical Specification Subsection 550.00, except that traffic control is a separate pay item for this contract.

As part of the Transportation Plan, the Contractor shall submit a Traffic Control Plan as described by Technical Specification Subsection 550.00. In addition to the requirements of Technical Specification Subsection. The Plan shall meet the requirements of the United States Department of the Interior Bureau of Mines Information Circular No. 8758.

Abandoned Highway 10, which is under the jurisdiction of Butte-Silver Bow County, passes south of MWRR 2. The Owner has obtained permission from Butte-Silver Bow County to control access

to this road between Centennial Avenue west of Butte and Rocker. The Contractor shall control public access to this road to ensure safety in the vicinity of MWRR 2. Control may consist of barriers, gates or other devices which the Contractor deems necessary and which is approved by the Owner's Representative.

A winter shut-down period is anticipated. No traffic control shall be required during the winter-shut down period but all roads except Abandoned Highway 10 shall be left in safe and travelable condition for the winter shut-down period. Abandoned Highway 10 shall remain closed during the winter shut-down period.

Traffic control at the railroad crossings will be conducted with the Contractor's flag crews in accordance with the terms and conditions of a separate contract between Owner and Rarus Railway. Generally, the Contractor shall provide one or more flagmen to be present during train movements through the project area and to prevent traffic from using the two rail crossings during these train movements, all as part of an approved Traffic Control Plan for the site. Under the railroad agreement, Rarus Railway is to make every reasonable effort to communicate and coordinate its business activities on the Property with Owner and Contractor. On a daily basis, Rarus is to provide Owner/Contractor with the day's operating schedule, so that Owner/Contractor can organize its construction activities so as to minimize or eliminate any business interruptions to the railroad. To ensure the safety of construction personnel, Rarus is also expected to immediately notify Owner/Contractor of any change in its daily operating schedule. In addition, Rarus is to familiarize Owner/Contractor with any track safety procedures adopted by the railroad, including but not limited to, procedures for detecting and recognizing approaching trains, train approach warning signals, and, for any potential emergency situation, the rules and signals pertaining to giving proper stop signals to an approaching train and holding the train clear of the working limits, until the way is clear to proceed. The Contractor shall coordinate with Rarus Railway in the development of its Traffic Control Plan.

(l) **Groundwater Dewatering:** There are three major components to complete this work: (1) construction of sediment detention ponds, (2) construction of dewatering trenches with the associated dewatering pumping systems, and (3) operation and maintenance of the dewatering systems. Each sediment detention pond shall be constructed prior to the dewatering trenches associated with that pond.

(1) **Sediment Detention Ponds:** Six sediment detention ponds shall be located at the general locations shown on the Sheets M6a-M6d of the Drawings. The Contractor may propose alternate locations and construction methods for the sediment detention ponds subject to the approval of the Owner's Representative. The Contractor is responsible for any surveying required to construct the ponds. As shown on the plan sheets, the inlets and outlets of the ponds shall be located on opposite ends of the ponds lengthwise. The ponds shall be constructed to the lengths and widths listed on Drawing Sheet M6e. These dimensions are for the insides of the top of the berms.

Drawing Sheet M6e shows construction details of the ponds. The sediment detention ponds shall be constructed by first removing and stockpiling the topsoil in the area of the ponds. Depth of topsoil to be removed shall be approximately 6" or to the depth determined by the Owner's Representative. Then construction shall be accomplished by excavating non-impacted on-site soils and placing the excavated soils in lifts in accordance with Technical Specification Subsection 202.00, Excavation and Embankment, except for the changes in Note 1 of Drawing Sheet M6e. The surface of each lift should be scarified sufficiently to prevent slippage before placement of the next lift. For purposes of this work item, the Contractor shall disregard any reference to Technical Specifications Subsection 310.00, Cover Soil in Technical Specification Subsection 202.00. The Contractor is required to conduct at least one field compaction test for every lift of each sediment basin berm embankment, in accordance with Technical Specification Subsection 202.00. Moisture/density characteristics of the soil shall be determined by the Contractor at each sediment pond location, in accordance with Technical Specification Subsection 202.00.

While in service, the embankments and disturbed areas of the sediment detention ponds will not be covered with topsoil. Topsoil replacement will occur after removal of the sediment retention ponds. To the extent possible, the upgradient slopes of the ponds may be cut into the existing ground. The depth of the ponds shall be 3.5 feet from the top of the embankment to the bottom of the basin.

Drop-inlet structures for the outlet pipes are 12 inches nominal diameter and are made of high density polyethylene (HDPE). Pipe type is specified on the Drawing M6e.

For purposes of this work item, the Contractor shall disregard any reference to Technical Specification Subsection 210.00, Trench Excavation and Backfill and Subsection 620.00, Sanitary Sewer Mains and Service Connections, in Technical Specifications Subsection 610.00. The excavation of the trench for the pipe shall meet OSHA and Department of Labor, Safety, and Health Regulations for Construction. The bottom of the trench shall be accurately graded to the line and grade on the Drawings. The trench width shall provide adequate working room to install the pipe and compact the backfill. No standing water will be allowed in the trench and the Contractor shall provide local dewatering as necessary at no additional cost to the Owner. The backfill material shall be the excavated from on-site material. Backfill in the trench within 12 inches of the outlet pipe shall have a maximum particle size of one inch diameter, shall be placed in 6-inch maximum lifts, and compacted by tamping. Special care shall be taken to assure complete compaction under the haunches of the pipe. Backfill shall be compacted to at least 95% of maximum standard proctor density.

The discharge inlet sections of the sediment detention ponds shall be protected from erosion with bank stabilization fabric covered by Type 2 stone. The discharge areas from the ponds into the diversion channel or reconstructed channel shall also be protected with bank stabilization fabric and Type 2 stone. Bank stabilization fabric shall be provided in accordance with Technical Specification Subsection 650.02C, Construction Fabric. Type 2 stone shall be provided and installed in accordance with Technical Specification Subsection 535.00, Stone. Type 2 stone is available at the rock stockpile west of MWRR 2 at no cost to the Contractor.

After the ponds have been deactivated, the sediment detention ponds shall have the piping, anti-seepage collars, and inlet erosion protection removed and salvaged, if possible. All non-salvageable material shall be disposed off site. The embankments are to be graded back to existing ground topography. Topsoil shall be replaced and spread evenly over the disturbed areas. The disturbed areas shall be revegetated under a separate contract.

Prior to winter shut-down, dewatering trenches shall be backfilled. Sediment detention ponds may remain in place but must be drained prior to winter shut-down.

(2) **Groundwater Dewatering Trenches:** Fifteen groundwater dewatering trenches shall be excavated in the locations shown on Drawing Sheets M6a-M6d. The centerline of the groundwater dewatering trenches located within the reconstructed channel shall follow the centerline of the new channel. The new channel alignment is specified on Drawings I1 through I6.

The dewatering trenches shall be surveyed for line and grade by the Owner's Representative before construction commences. Offset cut stakes to the centerline of the dewatering trench shall be staked by the Owner's Representative at 50 foot intervals and marked with cuts to the trench invert. Trench invert elevations will be determined by interpolation of a straight grade between ditch endpoint invert elevations, as shown on the Drawings. The trench bottom width shall be 2 feet minimum.

Drawing Sheet M6e shows construction details for the trenches. Excavation of the trenches shall begin at the downgradient end with the sumps. The sumps shall be constructed as shown on Sheet M6e. The sumps shall be packed with washed gravel. Washed gravel is available from the rock stockpile west of MWRR 2 at no cost to the Contractor. The pumps shall have a minimum capacity of 50 gpm per 100 feet of trench. The pumps used for each trench shall be approved by the Owner's Representative. Pumping shall be initiated as soon as the sumps are completed.

The side slopes of the trenches shall be as steep as feasible and in compliance with OSHA and Department of Labor, Safety, and Health regulations to minimize material sloughs into the trenches. The tailings/impacted soils excavated from the trenches shall be disposed in MWRR 2. See Special Provision Section 8(J)(4) for a description of the tailings removal. Non-impacted material excavated below the tailings/impacted soils will be stockpiled on a non-impacted bench, as shown on Drawing Sheet M6e, and will be used for backfill of the trenches.

The trenches shall be constructed sequentially. Only one trench shall discharge to a given sediment detention pond at a time. After the construction of each trench is completed, and the Owner's Representative has determined the discharge is adequately free from sediment, the dewatering discharge will be rerouted from the sediment ponds to the diversion channel or reconstructed channel. At this time, dewatering of the next trench may begin. The new discharge areas along the diversion channel or reconstructed channel shall be protected from erosion with bank stabilization fabric and Type 2 stone. Bank stabilization fabric shall be provided in accordance with Technical Specification Subsection 650.02C, Construction Fabric. Type 2 stone shall be provided and installed in accordance with Technical Specification Subsection 535.00, stone.

The Contractor shall provide erosion protection measures such as small berms or silt fence to prevent migration of impacted sediment into the open trenches during rain events. Silt fence shall be in accordance with Technical Specification Subsection 650.00, Construction Fabric.

Groundwater dewatering trenches shall remain in operation until the floodplain is backfilled and channel construction is complete. Those dewatering trenches that are located within the new channel corridor will be deactivated as the channel corridor construction proceeds and obliterates the trenches. After the dewatering trenches are deactivated, the sump pipes shall be removed and the trenches shall be backfilled with the non-impacted stockpiled material. The backfill shall be compacted to 90% of maximum dry density.

(3) **Operation and Maintenance:** Once pumping is initiated in a dewatering trench, it shall operate continuously until construction requiring dewatering in that area is completed. In order to meet this requirement, a backup pumping system shall be available onsite consisting of a spare pump and generator (or compressor, depending on the system used by the Contractor). A backup system shall be available at all times during the operation of the dewatering system.

(J) **Tailings/Impacted Soils Excavation:** Tailings/impacted soils excavation includes all activities associated with removal of the tailings/impacted soils from the floodplain and transport to MWRR 2. It includes excavation, hauling, dust control, and any other activities necessary to complete the task that do not appear as work elements. Groundwater Dewatering is described in Special Provisions Section 8(I) and is not a part of this work item. Lime amendment and compaction of the tailing/impacted soils in MWRR 2 is described in Section 8(N)(2) and is not part of this work item.

Prior to excavation of tailings/impacted soils, the Owner's Representative will stake the excavation surface according to Drawing Sheets M5a-f. The plan sheets show a grid of staking points on 50 foot centers with an accompanying excavation elevation for each point. Cut stakes will be set by the Owner's Representative at each grid point indicating the cut to the excavation elevation. The Owner's Representative will keep a record of all cuts for volume calculation purposes. The horizontal extent of tailings will be staked where it intersects each 50-foot north-south grid line by scaling the distance from the nearest grid point on the plan sheets. Each stake marking the horizontal extent shall be marked with a 0.5 foot cut. In tailings/impacted soils areas requiring construction of dewatering trenches, the diversion channel, or haul roads, surveying will be performed prior to commencement of these activities.

In anticipation of winter shut-down, the Contractor shall minimize the amount of excavated area in the floodplain that remains without backfill prior to shutting-down for the winter. The Contractor is responsible for ensuring that erosion controls are in place at the beginning of the winter shut-down to protect any excavated area that has not been backfilled. Silt fence shall be placed between the excavated area and the original stream channel.

(1) **Haul Road Tailings/Impacted Soils Removal:** Before construction of haul roads, tailings/impacted soils must be removed from beneath the haul road. Tailings/impacted soils shall be removed to the elevations shown on the staking plan in areas where the haul road crosses such materials in Reaches A , B and C, as shown on Drawing Sheet M5f. Because the materials may be saturated and dewatering will not be instituted in these areas, some materials may be too wet to be hauled directly to MWRR 2. These materials will be stockpiled on nearby undisturbed tailings/impacted soils, allowed to drain, and hauled to MWRR 2 at a later time.

(2) **Diversion Channel Tailings/Impacted Soils Removal:** Before construction of the diversion channel, tailings/impacted soils must be removed. Tailings/impacted soils shall be removed to the elevations shown on the staking plan and handled separately from non-impacted materials. Because the materials may be saturated and dewatering will probably not be instituted at the time diversion channel construction commences, some materials may be too wet to be hauled directly to MWRR 2. These materials will be stockpiled on nearby undisturbed tailings/impacted soils, allowed to drain, and hauled to MWRR 2 at a later time.

(3) **Groundwater Dewatering Trench Tailings/Impacted Soils Removal:** Before construction of groundwater dewatering trenches, tailings/impacted soils must be removed to the elevations indicated on the staking plan and handled separately from non-impacted materials. Because the tailings/impacted soils may be saturated, some materials may be too wet to be hauled directly to MWRR 2. These materials will be stockpiled on nearby undisturbed tailings/impacted soils, allowed to drain, and hauled to MWRR 2 at a later time.

(4) **Abandonment of Existing Monitoring Wells:** Four existing groundwater monitoring wells, GS27S, GS27D, C-16 and C-17, shall be abandoned during tailings/impacted soils removal activities. The four wells are located between the Interstate 90/15 bridges and near Whisky Gulch and are shown on Drawing Sheets M4a and M4c. Abandonment shall be in accordance with Technical Specification 511.00, Abandon Existing Monitoring Wells. Well abandonment information is found in Table III-2.

TABLE III-2
WELL ABANDONMENT INFORMATION

Well ID:	GS27S	GS27S	C-16	C-17
Casing Type	2" PVC	2" PVC	4" PVC	4" PVC
Depth to Water (feet)	4.85	4.83	2.5	2.2
Total Depth (feet)	12	22.2	8.4	9.0

Note: Measurements are below ground surface; data taken from well logs.

A piezometer, CT-84-7, is located near wells GS27S and GS27D. It can be removed without abandonment as can any piezometers located within the floodplain.

(5) **General Tailings/Impacted Soils Removal:** With the exception of the materials described above, tailings/impacted soils will only be removed after dewatering has occurred for a minimum of two weeks. This mandatory dewatering period will allow the greatest amount of material to desaturate before excavation and will facilitate amendment and compaction of the materials at MWRR 2. Excavation will be conducted in accordance with Technical Specification Subsection 202.00, Excavation and Embankment, and the excavated grade shall be within 0.2 feet of the excavation elevation marked at the cut stakes. Between cut stakes, the operator shall excavate to an evenly graded surface but shall not over-excavate or fill areas to obtain that surface. The 0.2 foot tolerance is not expected to be achieved in areas between cut stakes. The excavation surface shall be evenly graded between the nearest cut stakes on each side of Silver Bow Creek, however the excavation shall extend only to the existing streambanks of the stream.

Removal of the existing in-stream sediments in areas, coincident with the new stream channel, will be accomplished in accordance with Section 8(K) of these Special Provisions. Technical Specification Subsection 202.00 applies for the work except that groundwater dewatering costs are a separate pay item for this contract. Any incidental local dewatering will be considered part of the work and will be considered part of the tailings/impacted soils removal pay item.

(6) **Tailings/Impacted Soils Haul:** Tailings/impacted soils shall be hauled to MWRR 2 using the constructed haul road where feasible. Use of public roads shall be restricted to the haul of tailings/impacted soils from the area between the Interstate 90/15 bridges and to public road crossings. Hauled materials shall be sufficiently dry to allow transporting with minimal spillage. Any

spillage on public roads shall be immediately removed and placed in MWRR 2. Any leftover spillage on the haul road shall be removed at the completion of tailings/impacted soils excavation and placed in MWRR 2. Dust control for the haul roads shall be in accordance with Section 8(Z), Provide Water, of these Special Provisions.

(7) **Verification of Tailings/Impacted Soil Removal:** The Owner shall verify that tailings/impacted soils have been removed in accordance with the criteria stated in the Final Design Report. This verification consists of a statistically valid sampling procedure which will demonstrate that 90 percent of the tailings/impacted soils (as defined by the order of magnitude break criteria) have been removed. Further description of the verification procedure is found in the Construction Quality Assurance Plan (CQAP). Because this verification procedure depends on large sample numbers to be obtained over time, the Contractor will not be directed to perform additional excavation of specific areas. The Contractor shall excavate to the grades shown on plans M5a-f.

(K) **In-Stream Sediments Excavation:** Contaminated in-stream sediments shall be excavated and disposed in MWRR 2. As shown on Sheet M7a through M7d of the Drawings, in-stream sediments will be removed from those areas where the existing and reconstructed channels coincide. The Owner's Representative will stake the reconstructed channel alignment and identify areas of in-stream sediment removal prior to excavation. In these locations, this work item shall consist of removal of the upper one (1) foot of in-stream sediment and hauling this material to MWRR 2. Excavation downstream of station 12+00 will be performed in non-flowing conditions following diversion of Silver Bow Creek. Excavation of the in-stream sediments that coincide with groundwater dewatering trenches will occur prior to or during excavation of the groundwater dewatering trenches (Special Provisions Section 8(I)). Saturated instream sediments shall be stockpiled on nearby undisturbed tailings/impacted soils, allowed to drain, and hauled to MWRR 2 at a later time. The estimated volume of in-stream sediment to be removed downstream of station 12+00 is about 1,200 cubic yards.

In the reconstructed channel upstream of station 12+00, in-stream sediments will be excavated in the areas dewatered by cofferdams during reconstruction of the streambed and streambanks. This work item shall consist of removal of the upper one (1) foot of in-stream sediments and hauling this material to MWRR 2. The volume of contaminated in-stream sediment in the reach upstream of station 12+00 is estimated to be 800 cubic yards.

Contaminated sediments excavated from Silver Bow Creek will be hauled to MWRR 2 when the sediments are sufficiently dewatered to be hauled without spillage or loss of material. Instream sediments will be lime amended at the same rate as the standard rate for tailings/impacted soils identified in Section 8(N)(2) of these Special Provisions.

The Owner will obtain verification samples from the area where in-stream sediment has been removed to determine that the metals levels remaining in these areas are consistent with metals levels remaining in the floodplain. The sampling procedures to be used are described in the CQAP. Because a large number of samples collected over time will be required to verify compliance, the Contractor shall not be directed to perform additional excavation in specific areas.

(L) **Diversion Channel:** A diversion channel shall be constructed on the north side of the site to divert stream flows around the work area during construction. The diversion channel is intended to remain in place after completion of this contract for a number of years while the streambanks and floodplain reestablish vegetation. Reclamation of the diversion channel is not part of this contract. Temporary seeding of the top surfaces and outer banks of the diversion channel is to be performed under a separate contract. This work item includes site preparation, channel excavation, levee construction, channel lining, outfall construction, and incidental dewatering. Construction of the diversion channel shall be in accordance with Technical Specifications Subsection 548.00, Diversion System, and Drawing Sheets I1 through I6, I16 through I22, I24 and I25.

The Owner's Representative will survey the diversion channel for line and grade in accordance with the Drawings. The channel will be staked at 100 foot stations, unless otherwise shown on the Drawings, using offset stakes on each side of the channel. Diversion channel offset stakes shall be surveyed in accordance with Drawings I16 through I22. The stakes will be marked with offset distances to the toe of the channel construction corridor, cuts or fills to the top of the levee, and cuts to the base of the

channel construction corridor. The channel construction corridor is the channel cross-section before lining stone has been placed in the channel.

(1) **Site Preparation:** The area necessary for construction of the diversion channel will be cleared and grubbed in accordance with Special Provisions Section 8(F) and debris will be removed in accordance with Special Provisions Section 8(G). In areas where the diversion channel encounters tailings/impacted soils, these materials shall be removed and disposed of in accordance with Special Provisions Section 8(J).

(2) **Diversion Channel Excavation and Levee Construction:** The diversion channel shall be excavated to the lines and grades shown on Drawing Sheets I16 through I22. Excavated material shall be cast to either side of the channel to construct levees where designated on the Drawings. Levees shall be constructed in accordance with the Drawings and with Technical Specifications Subsection 202.00, Excavation and Embankment, and Subsection 548.00, Diversion System. Field compaction testing of the levee shall be conducted by the Contractor in accordance with Technical Specifications Subsection 202.00. In-place compaction requirements shall be 95% of maximum dry density. A minimum of one moisture/density field test will be taken per 200 cubic yards of compacted levee embankment. Moisture/density characteristics of the soil shall be determined by the Contractor as the material types change during construction, in accordance with Technical Specifications Subsection 202.00. At the county road crossing, a culvert shall be placed as described in Special Provisions Section 8(Q), County Road Culvert Crossing.

(3) **Diversion Channel Lining:** The diversion channel shall be lined with the materials specified on the Drawings. Rock shall meet the requirements of Technical Specifications Subsection 535.00, Stone. Stone for the channel lining is available at the stockpile west of MWRR-2 at no cost to the Contractor.

(4) **Diversion Channel Outfall:** A diversion channel outfall shall be constructed to protect the existing Silver Bow Creek channel from erosion. The work consists of placing a gabion mattress, bank stabilization fabric, and stone as shown on Drawing Sheet I25. This work shall be performed in accordance with Technical Specifications Subsections 548.00, Diversion System; 525.00, Gabions; 650.02C, Construction Fabric; and 535.00, Stone.

(5) **Incidental Dewatering and Cofferdams:** When required, the excavated channel shall be dewatered to permit placement of stone. The existing stream will need to be blocked with cofferdams to prevent flooding of the work area. Both incidental dewatering and cofferdams shall be accomplished in accordance with Technical Specifications Subsection 545.00, Incidental Dewatering and Cofferdams.

(M) **Diversion Structure:** A diversion structure shall be constructed to divert Silver Bow Creek into the diversion channel both during and after construction activities. At the completion of this contract, the diversion structure shall remain in place for a period of years while the streambanks and floodplain revegetate. During this period, flows up to approximately 50 cfs shall be directed to the newly constructed channel while flows in excess of 50 cfs will automatically overflow into the diversion channel. This work item consists of site preparation, diversion structure construction, diversion culvert placement, and incidental dewatering.

The Owner's Representative shall layout the diversion structure according to the dimensions shown on Sheet I23 of the Drawings.

(1) **Site Preparation:** The area required for construction of the diversion structure shall be cleared and grubbed in accordance with Section 8(F) and debris will be removed in accordance with Section 8(G) of these Special Provisions. Tailings/impacted soils in the construction area shall be removed and disposed of in accordance with Section 8(J) of these Special Provisions prior to construction of the structure.

(2) **Diversion Structure Construction:** The diversion structure consists of a diversion berm, diversion culverts, and an overflow spillway. The berm and spillway shall be constructed in accordance with Sheet I23 of the Drawings and Technical Specifications Subsections 202.00, Excavation and

Embankment; 548.00, Diversion System; 525.00, Gabions; and 535.00, Stone. The diversion structure berm shall be constructed after completion of the diversion channel. Field compaction testing of the berm shall be conducted by the Contractor in accordance with Technical Specifications Subsection 202.00. In-place compaction requirements shall be 95% of maximum dry density. A minimum of one moisture/density field test will be taken per 100 cubic yards of compacted levee embankment. Moisture/density characteristics of the soil shall be determined by the Contractor as the material types change during construction, in accordance with Technical Specifications Subsection 202.00. Stream flow shall be diverted into the diversion channel by means of a temporary flow barrier in accordance with Technical Specifications Subsection 545.00, Incidental Dewatering and Cofferdams, during construction of the diversion structure. Upon completion of the diversion structure, the temporary flow barrier shall be removed and flows within Silver Bow Creek shall be diverted into the diversion channel solely by means of the diversion structure.

(3) **Diversion Culvert Placement:** The diversion culverts will allow normal stream flows to be diverted into the reconstructed channel after it is constructed. The culverts shall be placed in accordance with Technical Specifications Subsections 548.00, Diversion System. Upon completion of the reconstructed channel and upon approval of the Owner's Representative, the outlet through the diversion structure shall be opened and normal stream flows released to the reconstructed channel.

(4) **Incidental Dewatering:** When required, the construction area for the diversion structure shall be dewatered to facilitate construction in accordance with Technical Specifications Subsection 545.00, Incidental Dewatering and Cofferdams.

(N) **Mine Waste Relocation Repository 2 (MWRR 2) Construction:** Tailings/impacted soils, instream sediment, and waste material excavated from the floodplain, existing stream channel, and railroad embankments will be placed in Mine Waste Relocation Repository 2 (MWRR 2). Approximately 60 percent of the waste classifies as a sand or gravel and 40 percent of the waste classifies as a silt or clay. Information pertaining to typical properties of the in-place wastes is presented below.

Volume	169,100 cubic yards
Average moisture content, by weight	19.7%
Classification	Silty Sand
Estimated dry density	95.3 lbs/cf

Waste placed in the repository will be amended with lime products to reduce the acid generating potential of the waste and to immobilize heavy metals such as cadmium, lead and zinc. Material testing results for waste material amended with lime products are summarized below.

Lime amendment rate tested	52 tons lime/1,000 tons waste
Maximum laboratory dry density after amendment (ASTM D698)	109.6 lbs/cf
Optimum moisture content, by weight	16.9%
+/- 2% of optimum moisture content	14.9% - 18.9%
Dry density of recompacted amended waste (90% of maximum dry density, ASTM D698)	98.6 lbs/cf
Estimated volume of recompacted amended waste, including lime amendment	171,900 cy

Volume information for repository MWRR 2 is provided below.

Repository MWRR 2

Total potential waste storage volume (dry density 98.6 lbs/CF)	197,750 cy
Imported cover soil volume (for the soil cap)	15,250 cy
Topsoil salvage volume (to be used as part of the soil cap)	7,200 cy
Total Volume	220,200 cy

(1) **Site Preparation:** Preparation of the site will include clearing and grubbing, debris disposal, stripping and salvaging the uppermost six-inches of topsoil from inside the disturbance boundary, constructing a new drainage channel along the east side of the repository and constructing a haul road. Utility relocations have been done by others prior to construction of MWRR 2 except for removal of power poles in the existing lime pit. These abandoned power poles shall be removed from the site and disposed appropriately. **Monitoring wells have been installed around the repository. It is the Contractor's responsibility to prevent disturbance of these wells and restore them if they are damaged.**

Temporary run-on control ditches will need to be constructed along the north and west sides of the repository. A runoff ditch on the east side of the repository shall be constructed along the west shoulder of the haul road, and a runoff ditch shall be constructed along the south edge of MWRR 2 as shown on the Drawings.

Two construction sediment ponds shall be constructed on the south edge of MWRR 2 as shown on the drawings. Construction of the sediment pond berms shall be accomplished by excavating non-impacted on-site soils and placing the excavated soils in berms constructed in accordance with Technical Specification Subsection 202.00, Excavation and Embankment, except for the changes in Note 1 of Drawing Sheet M9f. For purposes of this work item, the Contractor shall disregard any reference to Technical Specifications Subsection 310.00, Cover Soil in Technical Specifications Subsection 202.00. The Contractor is required to conduct at least one field compaction test for every lift of each sediment basin berm embankment, in accordance with Technical Specification Subsection 202.00. Moisture/density characteristics of the soil shall be determined by the Contractor at each sediment pond location, in accordance with Technical Specification Subsection 202.00. Drop-inlet structures for the outlet pipes are 12 inches nominal diameter and are made of high density polyethylene (HDPE). Pipe type is specified on the Drawing M6e. For purposes of this work item, the Contractor shall disregard any reference to Technical Specification Subsection 210.00, Trench Excavation and Backfill and Subsection 620.00, Sanitary Sewer Mains and Service Connections in Technical Specifications Subsection 610.00. The excavation of the trench for the pipe shall meet OSHA and Department of Labor, Safety, and Health Regulations for Construction. The bottom of the trench shall be accurately graded to the line and grade on the Drawings. The trench width shall provide adequate working room to install the pipe and compact the backfill. No standing water will be allowed in the trench and the Contractor shall provide local dewatering as necessary at no additional cost to the Owner. The backfill material shall be the excavated onsite material. Backfill in the trench within 12 inches of the outlet pipe shall have a maximum particle size of one inch diameter, shall be placed in 6-inch maximum lifts, and compacted by tamping. Special care shall be taken to assure complete compaction under the haunches of the pipe. Backfill shall be compacted to at least 95% of maximum standard proctor density. After construction of the sediment ponds, topsoil shall be replaced and spread evenly over the berms and basins of the sediment ponds and disturbed areas. The topsoiled areas shall be revegetated under a separate contract.

After removal and salvage of the upper six inches of soil within the construction bounds, a survey of the MWRR 2 footprint will be conducted by the Owner's Representative to provide a basis for calculation of the volume of the repository. Local control points will be established to permit

resurvey of MWRR 2 on the same coordinate system. The survey will be conducted on a 50-foot grid or equivalent method by the Owner's Representative.

(2) **Lime Amendment:** The waste material will be amended with lime to reduce acidity and immobilize metals. Stockpiled lime is available to the Contractor at MWRR 2.

Lime will be applied according to an effective calcium carbonate equivalent (ECCE) rate measured as tons of ECCE lime per 1,000 tons of waste. ECCE is determined by first measuring the calcium carbonate equivalent of the material and then adjusting the value based on the material gradation and moisture content. The weight of grain sizes greater than 60 mesh and moisture content are subtracted from the calcium carbonate equivalent to determine the ECCE. Provided below are summary data for characteristics pertaining to the lime source.

Parameter	Lime Kiln Dust
Density, in place, lbs/cf	60 to 70
Weight, in place, tons	12,600
ECCE, in place, tons	9,400

The total ECCE required to amend waste material transported to MWRR 2 is estimated at 8,500 tons. Unless otherwise noted, lime will be applied at a master rate of 29 tons ECCE per 1,000 tons waste. Six areas have higher lime rates than the master rate. These areas and their corresponding higher lime rates are shown on drawing sheets M5b through M5d.

Lime incorporation into the waste may be achieved in several ways including:

- Agricultural tillage with disc or plow, and/or
- Windrowing with a grader or dozer, and/or
- Elevating scraper
- Pug mill
- Other methods developed by Contractor

Lime amendment incorporation will be conducted by the Contractor so that 100 percent of the waste material is properly amended in the upper 3 feet and lower 4 feet of mine waste in the repository. For the middle zone of the repository, between the upper 3 feet and lower 4 feet of amended waste, a minimum of 80 percent of the waste material shall be properly amended. All sampling and testing will be conducted by the Owner's Representative and quality assurance procedures for determining adequacy of mixing in each zone are described in the project *Construction Quality Assurance Plan*. The Contractor will submit to the Owner's Representative a written plan for waste amendment and placement. The plan will include the following items.

- A description of each step used in the amendment procedure: 1) waste handling, placement, weight determination; 2) lime handling, weighing, application; 3) mixing method; 4) drying method.

- Listing of each type of equipment used for amendment.

The 100 percent mixing requirement for the upper 3-foot and lower 4-foot zones will be verified by the Owner's Representative. The determination will be completed by first collecting composite samples of the amended material and testing the material for acid-base account and SMP single buffer lime requirement. All material within the upper 3 feet and lower 4 feet of the repository shall be adequately limed and therefore all samples analyzed are to exhibit a positive acid-base account. Next, field pH measurements will be taken of amended and placed materials. For the upper 3 feet and lower 4 feet of the repository, all tests must indicate a pH of at least 8.0. If mixing requirements are not met by the Contractor, the Owner's Representative will direct the Contractor to complete additional mixing as necessary to achieve the lime mixing requirement at Contractor's expense.

Within the interior, or middle zone, of the repository (i.e. excluding the lowermost four feet of waste above the subgrade and uppermost three feet of waste), 80 percent of the waste material shall be adequately amended. Field pH measurements will be taken of amended and placed materials. For the middle zone of amended waste, 80 percent of all tests must indicate a pH of at least 8.0. If mixing requirements are not met by the Contractor, the Owner's Representative will direct the Contractor to complete additional mixing as necessary to achieve the lime mixing requirement at Contractor's expense. Also, confirmation composite samples will be taken by the Owner's Representative and analyzed for acid-base account and SMP single buffer lime requirement.

In order to demonstrate the effectiveness of the proposed mixing method, the Contractor shall conduct an amendment mixing test before placing amended waste material in MWRR 2. Results of this test will be used to either verify that the proposed mixing method is adequate for the mixing requirements or to modify the mixing method to obtain acceptable results. The test will be conducted on a batch of waste material weighing at least 200 tons. If additional testing is necessary to obtain adequate mixing results, subsequent batches shall each weigh at least 200 tons. The source of the tailings material shall be determined by the Contractor, subject to approval by the Owner's Representative. Treatment of the first batch with lime will be followed by placement and compaction in the repository. Since the mixing test will be conducted on material comprising the lower 4 feet of the repository, 100 percent mixing requirements will apply. Following the Contractor's test of lime mixing, placement and compaction, quality assurance testing will be completed by the Owner's Representative. Further mixing and placement of waste material will not be allowed until laboratory results are received by the Owner's Representative. Reasonable efforts will be made by the Owner's Representative to expedite laboratory analyses. If it is determined that the amendment has been inadequately mixed or placed, the Contractor shall remix the material until satisfactory, revise the written plan for waste amendment and complete a new amendment mixing test on a separate batch of tailings material. This procedure will be repeated until satisfactory results have been obtained. Placement of amended waste material in the repository will be allowed only after satisfactory mixing test results are obtained.

The loading, transport, unloading, mixing, and placement of lime must be done in a manner that minimizes the amount of material being released to the environment because of potential loss of material and hazards the material poses to human health. The Contractor shall control lime dust when hauling, placing and mixing lime to avoid hazardous working conditions. **During windy periods, the Owner's Representative may delay or stop loading, transport, unloading, mixing and placement of lime until such time as weather conditions permit the material to be handled without excessive loss or hazard to human health.**

(3) **Moisture Content:** Wastes may not be transported to the repository if they contain sufficient water that water is draining from the material. Dewatering of wastes in the floodplain and excavation methods in the floodplain (e.g. incorporating drier wastes with wetter wastes) should minimize water draining from the wastes. If necessary, the wastes may need to be allowed to drain prior to transport to the repository.

(4) **Waste Compaction:** Wastes encountered during construction will generally vary in characteristics from sand and gravel to silt and clay. Following excavation, transport and amendment of wastes in the repository, most of the material should classify as silty sand prior to compaction. Low permeable amended wastes classifying as SC, CL, ML, CH, OH (ASTM D2487) are not allowed to be placed within 50 feet of the embankment face where the slope height is greater than 20 feet in height. Low permeable wastes may be mixed with more permeable material (e.g. sand or gravel wastes) to produce a granular material which will freely drain liquids following compaction. If large amounts of low permeable wastes are staged at the repository, and sufficient sandy material is not present for mixing, the staged material may be placed in discreet locations of the repository with written approval from the Owner's Representative. These locations will typically be in the northern half of the repository where slope stability is less critical. Sod materials may be placed in the northern half of the repository or within the uppermost five feet the repository final grade (not including coversoil) or in locations approved by Owner's Representative.

Amendment of the waste with lime products reduces the maximum dry density and increases the optimum moisture content for compaction as compared to unamended waste. Following

amendment the waste will be spread in loose horizontal lifts of 12 inch maximum height and compacted to a density of at least 90% of the maximum dry density as defined by ASTM D698. The Contractor may complete test pads to demonstrate that a thicker lift height can be used.

Amended wastes will be compacted in the repository at a moisture content within the range of + 2 to -4% of the optimum moisture content. Some of the waste material transported to the repository, and after amendment, will contain moisture contents in excess of this requirement and will need to be dried to obtain a moisture content within the allowable range prior to compaction. Drying may be accomplished by periodically tilling the material or other suitable methods.

Following placement of each lift of compacted waste, the surface of the lift will be scarified to a depth of at least 2 inches to minimize any low permeable crusts at the surface and increase the bonding with the next lift applied.

Material testing of the waste material will be completed by the Contractor. Material testing requirements are provided below. These testing requirements are for amended waste, following mixing, drying, wetting and other types of treatment necessary to achieve acceptable characteristics prior to compaction. Additional testing will be necessary for the lime amendment mixing test, test pads and for determining what treatment (e.g. material drying, mixing of wastes) needs to be performed.

Characteristic	Test Method	Frequency
In-place Moisture and Density Determination	ASTM D2216 and C602	Every 300 cubic yards
Particle Distribution	ASTM C136, C117, D422, D1140, C602	As needed to properly characterize material types and every 2,000 cubic yards thereafter.
Moisture Density Relationship	ASTM D698 (AASHTO T-99)	As needed to properly characterize material types and every 2,000 cubic yards thereafter.
Liquid Limit-Plastic Limit	ASTM D4318	As needed to properly characterize material types and every 2,000 cubic yards thereafter.

The Contractor may meet either the applicable ASTM or AASHTO standard.

Results of the material testing will be immediately forwarded to the Owner's Representative upon receipt by the Contractor. The Contractor, with guidance from the materials testing firm retained by the Contractor, is responsible for tracking the location and associated characteristics of wastes being placed in the repository. The Contractor must provide sufficient survey control such that test locations ca be relocated within five feet of actual locations.

After final grading of the surface of the amended tailings, a survey of the waste surface elevations will be completed by the Owner's Representative. The survey will be completed on a grid network with survey points established every 50 feet or other method compatible with the initial survey. These surveys shall be used to calculate the volume of compacted waste for payment.

(5) **Soil Cap/Final Grading:** The soil cap placed over the repository will involve first placing the salvaged topsoil to a depth of approximately six inches and then placing imported borrow material as needed to achieve the required thickness. Placement of the salvaged topsoil beneath the imported borrow is being conducted to reduce weed propagation. The imported borrow material will be placed in one lift to reduce compaction. Additional borrow material may be needed to achieve the specified thickness. The thickness of the cover soil is to be verified by completing a survey using a method compatible with the method used to establish the amended tailings surface.

Construction of the access road for the sediment basins (See Drawing Sheet M10f) should be conducted following completion of the repository and when the haul road to the repository is no longer necessary. The runoff ditch on the east side of the repository will be removed when the haul road is reclaimed. The construction sediment ponds will be left in place at the end of this contract. The lime stock pile area east of the repository will be regraded.

Construction of the permanent runon control ditches will be part of constructing the soil cap.

All disturbance areas outside of the footprint of the repository will be reclaimed by placing a minimum of six inches of stockpiled topsoil.

(6) **Winter-Shut-Down:** If a winter shut-down is necessary, the Contractor shall take steps to ensure that the repository materials are not subject to erosion and do not generate air-borne particulates. The Contractor shall import soil from the designated borrow source and cover all mine waste at the repository site with three (3) inches of soil compacted in-place to 90% of maximum dry density. The Contractor shall mulch the compacted soil with 1.5 tons per acre straw and crimp it in accordance with Technical Specification 330.00.

(O) **Reconstructed Channel Corridor Construction:** Approximately 6,440 feet of stream channel will be reconstructed to convey the flow of Silver Bow Creek. The reconstructed channel will be constructed in the floodplain after removal of tailings/impacted soils, as described in Special Provisions Section 8(J). The reconstructed channel will include two different channel types: a channel with a deformable bed and banks, and a non-deformable channel. The deformable channel type occurs downstream of the diversion structure (5,600 feet of channel), and the non-deformable channel type occurs upstream of the diversion, between the Interstate Highway bridges within 1,200 feet of existing channel, of which 360 feet will be excluded from construction, for a total reconstructed channel length of 840 feet. This work item shall consist of channel corridor excavation, and incidental dewatering.

The Owner's Representative shall survey the reconstructed channel for line and grade in accordance with Drawing Sheets I1 through I11. The channel will be staked according to centerline coordinates at each cross-section shown on the Drawings, using offset stakes on both sides of the channel. The stakes will be marked with offset distances to the toe of the channel construction corridor, cuts or fills to the top of the bank, and cuts to the base of the channel construction corridor. The channel construction corridor is the excavated channel cross-section prior to placement of bed material or construction of streambanks. During staking, existing ground elevations shall be determined for purposes of volume computation.

In anticipation of winter shut-down, the Contractor shall minimize the amount of channel corridor excavation that is uncompleted at the time of shut-down. The Contractor shall attempt to complete as much streambed and streambank construction as possible to minimize the amount of excavated channel left exposed during the shut-down period. The Contractor shall place orange constuction fence around any remaining open excvation.

(1) **Channel Excavation:** The channel construction corridor shall be excavated after tailings/impacted soils have been removed in accordance with Section 8(J) of these Special Provisions, and groundwater dewatering trench excavation has been completed in accordance with Section 8(I) of these Special Provisions. Remaining excavation required to construct the reconstructed channel is covered under this item. Excavation shall be conducted in accordance with Technical Specifications Subsection 202.00, Excavation and Embankment; and 205.00, Reconstructed Channel. Non-impacted material excavated under this item will remain on-site and be used to backfill the reconstructed channel and floodplain. Groundwater dewatering trenches will be excavated along a major portion of the reconstructed channel length (Drawing Sheets M6a-M6d). These trenches shall remain in place during channel excavation to facilitate dewatering.

During channel excavation in areas where the reconstructed channel crosses the existing channel, in-stream sediment removal will be required in accordance with Section 8(K) of these Special Provisions.

(2) **Incidental Dewatering:** For those portions of the reconstructed channel where groundwater dewatering trenches are not in place, additional dewatering may be required. This incidental

dewatering shall be conducted in accordance with Technical Specifications Subsection 545.00, Incidental Dewatering and Cofferdams.

(P) **Deformable Streambed and Streambank Construction:** The streambed and streambanks of the reconstructed, deformable channel shall be constructed in accordance with Sheets I2 through I15 of the Drawings. This work item consists of streambed material placement, streambank construction, and seeding of the streambanks.

Surveying requirements for streambed and streambank construction are addressed under Section 8(O), Stream Channel Corridor Construction. Both riffle and pool sections occur within the reconstructed, deformable channel. Staked cross-sections will be used to define where different channel types (riffle or pool) begin and end. If stakes have been lost or destroyed during channel excavation, they will be replaced by the Owner's Representative.

(1) **Streambed Material Placement:** Streambed material shall be placed in accordance with the Drawings and Technical Specifications Subsections 205.00, Reconstructed Channel, and 535.00, Stone. Both riffle and pool sections occur within the reconstructed channel. Placement of streambed material will be according to the specified section type (riffle or pool) as field staked, and as shown on Sheet I12 of the Drawings. Streambed material will be placed at two different times. Initially, material shall be placed under the banks. After the banks are constructed, additional material will be placed in the reconstructed channel. This will allow fabric placed during streambank construction to be staked to the floor of the channel corridor, followed by placement of streambed material.

(2) **Streambank Construction:** This work item includes placement of subsoil, cover soil, organic soil amendment, seed and coir fabric. The linear distance of streambank construction for each channel type (riffle and pool) shall be based on the channel centerline distance between cross-sections, as shown on Sheets I3 through I6 of the Drawings. Streambanks shall be constructed in accordance with Sheets I7 through I15 of the Drawings and Technical Specifications Subsections 205.00, Reconstructed Channel; 315.00, Organic Soil Amendment; and 345.00, Coir Fabric Materials. Compaction testing of the streambank materials shall be conducted by the Contractor. A minimum of one moisture/density field test per 200 compacted cubic yards of streambank subsoil and a minimum of one moisture/density field test per 200 compacted cubic yards of streambank cover soil shall be taken, in accordance with Technical Specifications Subsection 202.00, Excavation and Embankment.

(3) **Streambank Revegetation:** Streambanks shall be seeded in accordance with the Drawings and Technical Specifications Subsection 328.00, Streambank Seeding. All other plantings and revegetation of the streambanks will be accomplished under a separate contract.

(Q) **County Road Culvert Crossing Construction:** A new county road crossing will be constructed to replace the existing double culvert installation at Station 38+30 on the reconstructed channel alignment. The new crossing will replace an existing deteriorated structure and provide better, more stable hydraulic conditions in Silver Bow Creek. Two culverts will be installed as part of this work item: one at the reconstructed channel alignment and one at the diversion channel alignment. One culvert will be placed during construction of the Diversion Channel and the other will be placed during reconstruction of the stream channel. Other requirements of this work item are culvert cutoff/headwall installation, road prism reconstruction, and removal of the existing culverts. During construction at the county road crossing, the Contractor shall coordinate activities with Butte/Silver Bow County and shall reroute traffic as necessary. The county road shall only be closed for the minimum amount of time necessary to remove and install the culverts.

(1) **Installation of Culverts:** Galvanized steel pipe-arch culverts will be installed at the diversion channel crossing and at the reconstructed channel crossing in accordance with Sheet I26 of the Drawings and Technical Specifications Subsections 548.00, Diversion System, and 610.00, Storm Drains and Culverts. Installation of the diversion channel crossing shall occur first. After diversion of the stream into the diversion channel, installation of the reconstructed channel crossing can commence. The trench for culvert placement shall be cut a minimum of 18 feet wide with at least 3 feet clearance on each side of the culvert. Backfill material within 3 feet of the culvert walls shall

be compacted in 6-inch maximum lifts to 95% of maximum dry density as determined by AASHTO T99. Culverts shall be bedded in a minimum of 6 inches of granular fill as detailed in the Technical Specifications. If existing material is unsuitable as bedding, as determined by the Owner's Representative, material will be imported for this purpose. Compaction testing of the streambank materials shall be conducted by the Contractor. A minimum of one moisture/density field test per lift of backfill at each culvert shall be taken, in accordance with Technical Specifications Subsection 202.00, Excavation and Embankment.

(2) **Installation of Culvert Cutoff/Headwalls:** Headwalls shall be constructed at the entrance and exit of each culvert to increase inlet efficiency, prevent uplift of the culvert lip, and prevent seepage flows from eroding soil around the pipe. The walls shall be cast-in-place concrete and shall extend to a depth of 3 feet below the culvert inverts, 4 feet beyond the sides of the culvert, and 1 foot above the culvert crown. The cast-in-place concrete shall be constructed according to Technical Specifications Subsection 710.00, Structural Concrete. Headwall bedding, and other culvert installation details are shown on Sheet I26 of the Drawings.

(3) **Reconstruction of Road Prism:** A new road prism shall be constructed to the lines and grades of the drawings, as shown on Sheet I26. The embankment material shall be in accordance with Technical Specifications Subsection 202.00, Excavation and Embankment, and compacted in 6-inch lifts to 95% of maximum dry density as determined by AASHTO T99. New road surface material shall be Crushed Top Surface-Grade 1 as stated in Technical Specification Subsection 820.00, Crushed Top Surfacing Course, and placed in a 6-inch lift with a compaction of 95% as determined by AASHTO T99. Road base material shall be Crushed Base Course-Grade 1 as stated in Technical Specifications Subsection 810.00, Aggregate Base Course, and placed in a 6-inch lift and compacted to 95% as determined by AASHTO T99. Compaction testing of the embankment material shall be conducted by the Contractor. A minimum of one moisture/density field test per 200 cubic yards of backfill shall be taken, in accordance with Technical Specifications Subsection 202.00, Excavation and Embankment.

(4) **Culvert Removal:** The two existing culverts shall be removed by the Contractor and all unsalvageable material shall be disposed of at a landfill. The road prism shall be reconstructed in accordance with Special Provisions Section 8(Q)(3) at the affected area.

(R) **Non-Deformable Stream Channel Reconstruction:** The streambed and streambanks of the reconstructed, non-deformable channel shall be constructed in accordance with Sheets I2 through I15 of the Drawings. This work item consists of dewatering of the active channel using a cofferdam system, excavation of streambank and streambed materials, streambed material placement, streambank construction, incorporation of organic matter, and seeding of the streambanks. No work shall take place within designated construction exclusion areas, as shown on the Drawings.

Surveying requirements for streambed and streambank construction are addressed under Section 8(O), Reconstructed Channel Corridor Construction. If stakes have been lost or destroyed during channel excavation, they will be replaced by the Owner's Representative.

If winter shut-down occurs during non-deformable stream channel reconstruction, the Contractor shall remove coffer dams and all other construction materials that could impede flow of the stream prior to shut-down. The channel shall be left in a condition that will minimize damage from flooding during the shut-down period.

(1) **Cofferdam Dewatering:** Dewatering of the non-deformable channel for both excavation and reconstruction will be conducted using a cofferdam system. Streamflow will be displaced to one side of the channel while the other is dewatered. This work item includes all incidental dewatering necessary to remove water from the excavation and construction areas on the dry side of the cofferdam. Cofferdams will be installed as shown on Sheet I27 of the Drawings and Technical Specifications Subsection 545.00. Cofferdams shall not extend into designated construction exclusion areas.

(2) **Streambed Material Placement:** Streambed material shall be placed in accordance with the Drawings and Technical Specifications Subsections 205.00, Reconstructed Channel, and 535.00,

Stone. The streambed material will be placed after the banks are constructed. This will allow installation of the streambank toe stone under the streambed gravel.

(3) **Streambank Construction:** This work item includes placement of streambank toe stone and installation of fabric wrapped upper bank structures. The linear distance of streambank construction shall be based on the channel centerline distance between cross-sections, as shown on Sheet I2 of the Drawings. The upper bank structure includes placement of inner and outer coir fabric, installation of subsoil, cover soil, organic soil amendment, seed and wood stakes. Streambanks shall be constructed in accordance with Sheets I7, I8, and I12 through I15 of the Drawings and Technical Specifications Subsection 205.00, Reconstructed Channel; 315.00, Organic Soil Amendment; and 345.00, Coir Fabric Materials. Compaction testing of the streambank materials shall be conducted by the Contractor. A minimum of one moisture/density field test per 200 compacted cubic yards of streambank subsoil and a minimum of one moisture/density field test per 200 compacted cubic yards of streambank cover soil shall be taken, in accordance with Technical Specifications Subsection 202.00, Excavation and Embankment.

(4) **Streambank Revegetation:** Streambanks shall be seeded in accordance with the Drawings and Technical Specifications Subsection 328.00, Streambank Seeding. All other plantings and revegetation of the streambanks will be accomplished under a separate contract.

(S) **Railroad Materials Remediation:** Railroad materials within or near Reach A will be remediated in the locations shown on Sheets M10a through M10d of the Drawings. Three work activities will be completed: (1) removal of selected areas of contaminated materials; (2) placement of rock cover over selected railroad embankments; and, (3) construction of sediment basins designed to control runoff and trap sediments from off-site railroad embankments.

If railroad materials remediation is taking place at the time of winter shut-down, all areas where railroad materials have been excavated shall be covered with rock prior to shut-down. Reasonable efforts shall be made to complete sediment basin construction needed to protect the floodplain where it has been remediated before winter shut-down.

(1) **Waste Material Excavation and Haul to MWRR 2:** Locations where selected areas of railroad materials will be removed are shown on Drawing Sheets M10a through M10d. Excavation details are on Drawing Sheet M10e. Limits of excavation will be staked by the Owner's Representative in the field. Excavation shall be in accordance with Technical Specification Subsection 202.00, Excavation and Embankment. Excavated material will be hauled to MWRR 2 for treatment with lime and placement according to Section 8(N) of these Special Provisions. Repository lime application rates for the railroad waste material shall be identical to the rate for floodplain tailings/impacted soils being amended at the time the railroad wastes are hauled to MWRR 2. During waste material excavation, the Contractor shall not disturb ballast or nick railroad ties. Rarus Railway is expected to provide some oversight of construction railroad embankments to ensure the integrity of the track and embankment is maintained. Contractor shall coordinate and cooperate with Rarus Railway to avoid impact to rail operations.

(2) **Rock Cover:** Locations to be remediated are shown on plan sheets M10a through M10d. Limits of rock cover shall be staked in the field by the Owner's Representative. The design consists of overlaying the waste material of the railroad embankment with a 6-inch (minimum) layer of rock cover material having evenly distributed particle sizes ranging from 3 inches to 1/4 inch (No. 4 sieve). Rock cover material shall be in accordance with Technical Specification Subsection 536.00, Rock Cover. Rock cover material is available at the rock stockpile west of MWRR 2 at no cost to the Contractor. Cover material shall be placed at the shoulder of the embankment, extend down the slope, and key into the remediated floodplain or existing ground at the embankment toe. At the shoulder of the embankment, the top 6 inches of waste material will be excavated and disposed in MWRR 2. Rock cover material will be placed in the excavated area, flush with the top of the embankment to allow positive drainage. The rock cover will then be placed on top of the existing slope waste material. No excavation of the slope material is anticipated unless it is steeper than 2 (horizontal) to 1 (vertical) and site restrictions prevent a wider rock cover layer at the toe, in which case the slope shall be reduced to 2:1. Any areas on cut slopes leading down to a railroad

embankment will have the toe area designed to maintain drainage ditches adjacent to the railroad. Details of the design are found on Drawing Sheet M10e.

(3) **Sediment Basin Construction:** Three sediment basins will be constructed at the locations shown on Sheets M10c and M10d of the Drawings. Drawing Sheets M10f and M10g show construction details of the basins. Construction staking will be performed by the Owner's Representative. Reference points for horizontal locations are provided on the Drawings. Horizontal and vertical control shall be from the control points shown on the Drawings. Sediment basins will be constructed by excavating on-site soils and placing the excavated soils in berms constructed to the lines and elevations shown on the Drawings and in accordance with Technical Specification Subsection 202.00, Excavation and Embankment except for the changes in Note 1 of Drawing M10g. The top of each compacted lift will be scarified sufficiently to facilitate bonding of the next lift. In subsection 202.00 disregard any reference to Technical Specifications Subsection 310.00, Cover Soil. Compaction testing of the embankment materials shall be conducted by the Contractor. A minimum of one moisture/density field test per lift of embankment at each basin shall be taken, in accordance with Technical Specifications Subsection 202.00. In-place compaction requirements are 95% of maximum dry density. Moisture/density characteristics of the soil shall be determined by the Contractor at each sediment basin location or as the material types change during construction, in accordance with Technical Specification Subsection 202.00.

Drop-inlet structures for the outlet pipes are nominal 12 inches in diameter and are made of high density polyethylene (HDPE). In Technical Specifications Subsection 610.00, disregard any reference to Technical Specification Subsection 210.00, Trench Excavation and Backfill and Subsection 620.00, Sanitary Sewer Mains and Service Connections. The excavation of the trench for the pipe shall meet OSHA and Department of Labor, Safety, and Health Regulations for Construction. The bottom of the trench shall be accurately graded to the line and grade on the Drawings. The trench width shall provide adequate working room to install the pipe and compact the backfill. No standing water will be allowed in the trench and the Contractor shall provide local dewatering as necessary at no additional cost to the Owner. The backfill material shall be the excavated onsite material. Backfill in the trench within 12 inches of the outlet pipe shall have a maximum particle size of one inch diameter, shall be placed in 6-inch maximum lifts, and compacted by tamping. Special care shall be taken to assure complete compaction under the haunches of the pipe. Backfill shall be compacted to at least 95% of maximum standard proctor density. After construction of the sediment ponds, topsoil shall be replaced and spread evenly over the berms and basins of the sediment ponds and disturbed areas. The topsoiled areas shall be revegetated under a separate contract.

Spillways have bottom widths of 10 feet and 2:1 side slopes. Basins S-1 and S-2 have two-foot depths at the control section. Basin S-3 has a control section depth of one foot. All spillways will be lined with Type 2 stone underlain with bank stabilization fabric. The upstream inlet section of each basin will be lined with Type 2 stone to prevent erosion. Maximum drop height of stone onto bank stabilization fabric shall be 18 inches. Bank stabilization fabric shall be in accordance with Technical Specification Subsection 650.00, Construction Fabric. Type 2 stone is available at the rock stockpile west of MWRR 2 at no cost to the Contractor. The stockpiled Type 2 stone meets the requirements of Technical Specification Subsection 535.00, Stone.

(T) **Excavation and Placement of Non-Impacted Floodplain Materials:** The final floodplain grade, as defined by Drawing Sheets M5a-M5e, will require excavation of material below the tailings/impacted soils excavation grade shown on the Drawings. The material below the tailings/impacted soils is non-impacted material. The non-impacted material shall be excavated to the grades shown on the Drawings after the tailings/ impacted soils have been removed in a given area. The non-impacted material shall then be placed in areas where greater than 6" of backfill are required. These materials shall not be placed within 6" of the final grade. The floodplain backfill shall be compacted to 90% of maximum dry density. Compaction testing of the backfill materials shall be conducted by the Contractor. A minimum of one moisture/density field test per 1,000 compacted cubic yards of backfill shall be taken, in accordance with Technical Specifications Subsection 202.00, Excavation and Embankment. Moisture/density characteristics of the soil shall be determined by the Contractor as the material types change during construction, in accordance with Technical Specifications Subsection 202.00.

Prior to excavation and placement of the non-impacted floodplain materials, the Owner's Representative shall stake the final grade according to Drawing Sheets M5a-M5e after the tailings/impacted soils removal. The Drawings show a grid of staking points on 50 foot centers with an accompanying final grade elevation for each point (Drawing Sheet M5e). Stakes shall be set at each grid point indicating the cut and fill to the final grade elevation. A record shall be kept of all cuts for volume calculation purposes.

(U) **Borrow Area Preparation and Final Grading:** The only borrow area site for this contract is Borrow Area 10, as shown on Drawing Sheet M8. Initial staking of Borrow Area 10 limits shall be limited to the area shown on Sheet M8. The Owner's Representative will stake the area limits. Field adjustments or changes to the borrow area limits may be determined by the Owner's Representative based on suitable soil textures and other backfill suitability criteria. After the borrow area is cleared and grubbed, the top 6 inches of topsoil shall be stockpiled. As excavation progresses, the borrow area shall be excavated to the contours shown on sheet M8.

The existing access road on the east side of the borrow area is to remain and be kept open for traffic. The Contractor shall be responsible for traffic control at the existing access road.

Final regrading of Borrow Area 10 shall be performed as necessary after all the required borrow has been excavated. The final grades shall provide positive drainage and shall blend with the surrounding topography. The final reclaimed surface shall have slopes no steeper than 4:1 H:V. The disturbed area shall be ripped, and then the stockpiled topsoil shall be spread evenly across the disturbed area. Revegetation will be accomplished under a separate contract.

Because winter-shut down is anticipated, the Contractor shall ensure that erosion controls are in place at the start of the shut-down period in order to minimize sediment loss from the site.

(V) **Borrow Area Excavation, Hauling, and Placing Floodplain Backfill:** Borrow materials for floodplain backfill shall come from Borrow Area 10, as designated on the Drawings. The borrow material shall be excavated to the elevations shown on Drawing Sheet M8 and as directed by the Owner's Representative who shall determine the suitability of all material in accordance with the CQAP. The Contractor shall implement an excavation approach that prevents ponding of surface water and erosion. Excavation cut faces where equipment is not working shall be immediately sloped back to a temporary 2H:1V slope or flatter. Side slopes shall be monitored by the Contractor for stability and potential safety concerns.

Borrow Area 10 material shall be used to bring the floodplain to final grade, as defined by Drawing Sheets M5a-M5f, after the non-impacted floodplain materials have been excavated and placed.

The borrow material shall be spread and compacted in the floodplain such that the final grades are in accordance with the final grade elevations shown on Drawing Sheets M5a-M5f. All floodplain backfill except the top 6 inches shall be compacted to 90% of maximum dry density. Backfill shall be placed in 12-inch maximum lifts prior to compaction. Compaction testing of the backfill materials shall be conducted by the Contractor. A minimum of one moisture/density field test per 1000 compacted cubic yards of backfill shall be taken, in accordance with Technical Specifications Subsection 202.00. Moisture/density characteristics of the soil shall be determined by the Contractor as the material types change during construction, in accordance with Technical Specification Subsection 202.00. The top 6 inches shall remain uncompacted for revegetation. The final surface grade shall be within 0.2 feet of the final surface elevation marked at the cut and fill stakes. Between cut and fill stakes, the operator shall provide an evenly graded surface. The 0.2 foot tolerance is not expected to be achieved in areas between cut and fill stakes.

Borrow material shall be hauled from Borrow Area 10 to the Reach A floodplain using the constructed haul road where feasible. Use of public roads shall be restricted to the haul of borrow material to the area between the Interstate 90/15 bridges and to public road crossings. Dust control of the haul roads and borrow area shall be in accordance with Special Provisions Section 8(Z), Provide Water and Section 8(H) Haul Roads.

The Owner's Representative will conduct survey staking to control the excavation and backfill to the lines and grades presented on the Drawings.

In anticipation of winter-shut-down, the Contractor shall make reasonable efforts to complete backfill of as much of the excavated floodplain as possible. The Contractor shall ensure that sufficient erosion controls are in place at the start of the shut-down period to minimize erosion. The backfilled floodplain will be either seeded or straw mulched and crimped under a separate contract before winter-shut down.

(W) **Revegetation:** The only revegetation covered under this contract will be the streambank seeding as described in Special Provisions Section 8(P)(3), Streambed and Streambanks Construction. All other revegetation will be accomplished under separate contract.

(X) **Fencing:** Three types of fencing will be installed in the construction area: Type F-5M or F-5W Farm Fence; Type F-2M or F-2W Combination Woven and Barbed Wire Fence; and wooden pole fence. For the farm and combination fences, the Contractor is given the option to use either metal or wooden posts.

The reconstructed floodplain and contractor's staging area will be fenced with Type F-5M or F-5W Farm Fence, as shown on Sheets M7a-d of the Drawings. MWRR 2 will be fenced with Type F-5M or F-5W Farm Fence, as shown on Sheet M9c of the Drawings. Fencing removed from the Ranchland Packing corral shall be replaced with the same type pole fence as shown on Sheet M7a of the Drawings. Type F-5M or F-5W Farm Fence shall be installed in accordance with Technical Specification Subsection 520.00. Gates for all fences will be located as shown on the Drawings.

Combination Woven and Barbed Wire Fence will be installed around the sediment basins that are constructed in conjunction with the railroad materials remediation as shown on Drawing Sheet M10f. Only the sediment basins on the north side of old Highway 10 that are outside the MWRR 2 fence shall be fenced with the combination fence. The sediment basins inside the MWRR-2 fence shall not be individually fenced. The combination fence shall be constructed in accordance with Technical Specification Subsection 520.00, Farm Fence, and the detail shown on Drawing Sheet M10g.

A portion of existing wooden pole fence at the Ranchland Packing stock corrals shall be removed by the Contractor for tailings/impacted soils excavation. After placement of new floodplain fill material, the fence will be replaced by the Contractor with new pole fence to match the existing. The same length of fence and corral dimensions as existing shall be maintained when the new fence is constructed.

The Contractor shall provide painted metal signs on all fences to warn the public that access is prohibited. The signs shall be securely mounted directly to the fences with the top of each sign no more than 3 inches below the top fence wire, spaced no more than 300 feet apart, and with wording facing away from the project site. Each sign shall have minimum dimensions of 24 inches wide by 18 inches high and shall have bold and clearly visible lettering. Each sign shall have the following inscription:

RESTRICTED AREA
HAZARDOUS MATERIAL RECLAMATION PROJECT
UNAUTHORIZED ACCESS PROHIBITED

Montana Department of Environmental Quality
U.S. Environmental Protection Agency

Existing fence within the disturbed areas will be removed and disposed in accordance with Section 8(G) of these Special Provisions.

(Y) **Site Security:** Site security shall be maintained during the period of construction at the site. The Contractor shall provide two security guards during working hours and one security guard during non-working hours for the duration of the construction project, excluding any winter shut down period. The security guards shall be fully trained in providing security and be licensed to provide security in Montana. Their duties throughout their shifts shall include patrolling all portions of the construction site on a regular basis and preventing unauthorized visitors from entering the construction site. The security guards shall also have 40-hour health and safety training for hazardous waste operations and emergency response (OSHA) training and current 8-hour refresher training.

(Z) **Provide Water:** The Contractor shall furnish and apply water required in all compaction work, dust control, and all other work items associated with this project. The water shall be reasonably clean and

free from acid, oil, alkali, or vegetable substances and shall not be brackish or salty. The Contractor shall be responsible for obtaining any necessary water rights, permits, and for payment of any royalty costs on the water provided. The source of water to be used shall be indicated to the Owner's Representative prior to use.

If water is drawn from Silver Bow Creek, the Contractor is not required to obtain a separate permit, but the following limitations apply: 1) a single tank load shall not exceed 3600 gallons; 2) the maximum pumping rate from the creek shall not exceed 200 gpm; 3) the total volume of water used for the contract period shall not exceed 6.19 acre-feet. The Contractor shall tabulate withdrawals from Silver Bow Creek and provide this information to the Owner's Representative.

Water, when required, shall be applied at the locations and in the amounts needed to properly complete the work. An adequate water supply shall be provided by the Contractor. The equipment used for watering shall be of ample capacity and of such design as to assure uniform application of water in the amounts required.

In the watering of subgrades and embankments, the Contractor shall apply water in such quantities that the subgrade and embankment are compacted at a moisture content in accordance with the Special Provisions or Technical Specification Subsection 202.00, Excavation and Embankment. The Contractor shall also apply water during the course of the work to control dust, maintaining all embankment and base courses in a damp condition.

The Contractor shall provide watering for dust control during construction and for maintenance of traffic on public roadways and other access roads as required by the Owner's Representative and the Montana Department of Environmental Quality air quality standards.

(AA) **Recontouring Floodplain to Accommodate Greenway Trail Construction:** Along the alignment of the proposed Greenway Trail, the Contractor will set the final contou and grade and will place a grushed aggregate surface in order to accomodate subsequent construction of the Greenway Trail under a separate contract. The Contractor shall construct the subgrade and place crushed aggregate surface course material for the Greenway Trail to the lines and grades shown on Drawings P1 through P12. The Greenway Service District will construct the final trail surface under a separate contract. The Greenway Service District is responsible for obtaining permission from landowners for construction of the Greenway Trail. In the event that permission is not granted by some or all landowners, only those portions of the trail subgrade for which Greenway Trail access permission has been obtained shall be constructed under this contract.

(1) **Trail Subgrade Construction:** Trail subgrade construction shall consist of grading and compacting the sub-base materials to 95% of maximum dry density, and providing, placing, compacting and grading crushed aggregate surface course material as described in Technical Specification Subsection 820.00, Crushed Top Surfacing Course. Trail subgrade construction shall commence at trail station 12+00.00 and end at trail station 69+00.00. The total length of trail subgrade (excluding diversion and stream crossings) to be constructed is 5402 linear feet. The total volume of crushed aggregate surface course to be placed is approximately 1550 BCY. The total volume of earthwork required to prepare the sub-base is approximately 1750 BCY.

(2) **Stream/Diversion Channel Crossings:** The proposed Greenway Trail crosses the diversion channel and reconstructed Silver Bow Creek channel in several locations. The Contractor shall not be responsible for installation of the crossings under this Contract. The Contractor shall end and resume trail subgrade construction at the locations designated on the Drawings.

(3) **Drainage Swale Construction:** Where required, trail subgrade construction will include construction of a drainage swale along the edge of the trail subgrade as shown on the drawings. Construction of approximately 3350 linear feet of swale by the Contractor will be required.

(4) **Surveying:** Construction staking for the trail subgrade and aggregate placement will be provided by the Greenway Service District and shall not be the responsibility of the Contractor.

9. LIST OF ESTIMATED WORK QUANTITIES

The quantities listed in Table III-3 are intended to be a guide for the Contractor in preparing its Bid. The unit quantities listed are not necessarily the same as the bid items listed in the Bid Form section of the Contract Documents and should be considered as supplementary to the bid items and not as pay items.

10. SUPERVISION BY CONTRACTOR

Paragraphs 6.01 and 6.02 of the General Conditions and Article 6 of the Supplementary Conditions contain requirements concerning supervisory personnel on site. Resumes of supervisory personnel shall be submitted to the Owner's Representative prior to the start of work. The resident superintendent shall not be replaced without written notice to Owner and Owner's Representative.

11. CONSTRUCTION STAKING

The Owner's Representative will furnish all primary control and establish control coordinates for locating the principal components of the Work with a suitable number of benchmarks adjacent to the Work. The Owner's Representative will develop and make all detailed surveys needed for construction of the work involved. The Contractor shall be held responsible for the preservation of all primary and other control coordinate stakes. If control stakes are carelessly or willfully destroyed or disturbed by the Contractor, the cost for replacing it by the Owner's Representative will be charged against him and such costs will be deducted from the payment for the work. Control points located within areas that must be disturbed can be removed without replacement at the Owner's Representative's discretion.

The Owner's Representative will perform all quantity calculation surveys using the methods described in Measurement and Payment at the end of the Special Provisions. Copies of the survey notes and calculations will be supplied to the Contractor upon request. The Contractor will note any discrepancies between the Owner's Representative's calculation and the Contractor's calculation within 10 days of receipt of the notes and calculations by the Contractor. Any discrepancies will be worked out to both parties satisfaction. If the Owner and Contractor cannot mutually agree, the procedures for resolving disputes shall be in accordance with the General Conditions.

12. USE OF PREMISES

The Contractor shall confine his equipment, storage of materials, and construction operations to the areas shown on the Drawings (staging, excavation, decontamination, haulage, etc.) or as set forth in Paragraph 6.11 of the General Conditions. The Contractor shall not unreasonably encumber the site or public rights-of-way with his materials and construction equipment. Should the Contractor deem it necessary to work outside of the general construction areas shown, it shall be necessary for the Contractor to obtain written approval by the Owner's Representative. The Contractor shall comply with all reasonable instructions of the Owner's

Representative and the ordinances and codes of government agencies regarding signs, traffic, fires, explosives, danger signals and barricades.

13. SITE CLEANUP

The Contractor shall periodically, or as directed by the Owner or Owner's Representative, during the course of the work remove and dispose of all surplus construction materials and debris and keep the project area and public rights-of-way reasonably clean. Upon completion of the work, the Contractor shall remove all temporary construction facilities, debris, and unused materials provided for the project, leaving the project site in a neat and clean condition. Costs of all cleanup work shall be considered incidental to other items of work and no additional compensation will be allowed. All debris shall be disposed of off-site in a state licensed solid waste management facility.

14. RESTORATION OF DISTURBED AREAS BY CONTRACTOR

All areas disturbed by the Contractor's operations such as, but not limited to, access roads, staging areas, haul roads, loading operations and disposal operations shall be restored by grading to the original contours as set forth in the Contract Documents. The Contractor shall include the cost of this work in the price bid for

TABLE III-3
ESTIMATED QUANTITIES
Reach A (Subarea 1) - SSTOU Remedial Construction

Description	Unit	Estimated Quantity
Clearing and Grubbing	AC	98
Debris Disposal	CY	930
Haul Roads		
Primary Haul Roads	LF	16,500
Existing County Road	LF	2,500
Stream Crossings	EA	2
Utility Crossings	EA	9
Public Road Crossings	EA	3
Railroad Approaches	EA	2
Diversion Channel Crossings (estimated)	EA	5
Side Drainage Culverts (sizes and lengths to be determined by the Contractor)	EA	8
Traffic Control	Man-Hours	6,050
Groundwater Dewatering		
15 Trenches with 15 Dewatering Systems	LF	7,700
Sediment Detention Ponds	Each	6
Operation and Maintenance	Weeks	18
Backfill and Compact	CY	17,000
Tailings/Impacted Soils Excavation and Hauling to MWRR 2 (159,200 cy from Reach A floodplain and 7,600 cy from haul road crossings)	CY	166,800
In Stream Sediments Excavation and Hauling to MWRR 2		
Upstream of Station 12+00	CY	800
Downstream of Station 12+00	CY	1,200
Lime Amendment	TONS	12,600
Reconstructed Channel Corridor Excavation		
Upstream of Station 12+00	CY	5,000
Downstream of Station 12+00	CY	26,500
Reconstructed Channel Construction		
Non-Deformable Channel (upstream of Station 12+00)	LF	840*
Deformable Channel: Pools (downstream of Station 14+00)	LF	1,080*
Deformable Channel: Riffles (downstream of Station 14+00)	LF	4,520*
Cover Soil	CY	1,200
Organic Amendment for Cover Soil (organic matter only)	TONS	45
Excavation and Placement of Non-impacted Floodplain Materials	CY	20,500
Diversion Channel		
Excavate Channel	CY	41,323
Riprap	CY	8,938

TABLE III-3
ESTIMATED QUANTITIES
Reach A (Subarea 1) - SSTOU Remedial Construction

Description	Unit	Estimated Quantity
Borrow Area 10 Preparation and Final Grading	AC	9
Borrow Area 10 Excavation, Hauling, and Placing Floodplain Backfill	CY	85,500
Mine Waste Relocation Repository 2 (MWRR 2) Construction		
Topsoil Stripping and Salvage	CY	7,200
Soil Cap Construction (7,200 cy replaced topsoil and 15,300 cy imported borrow)	CY	22,500
Fill for Haul Road at Repository	CY	14,600
Mixing of lime amendment, spreading, and compacting treated waste	CY	171,900
Type 2 stone for ditches and sediment ponds	CY	1050
Railroad Materials Remediation		
Waste Material Excavation and Hauling to MWRR 2	CY	150
Rock Cover	CY	2,350
Sediment Basins Construction	Each	5
Estimated Total Bank Cut Volume	CY	4,890
Estimated Total Compacted Fill Volume	CY	1,910
Fence		
Type F-5M or F-5W Farm Fence	LF	18,300
Type F2M or F-2W Combination Woven Wire and Barbed Wire	LF	1,050
Pole Fence	LF	500
Greenway Trail Base		
Greenway Trail Base	LF	5,402
Sub-Base Preparation	CY	1,750
Trail Crushed Surface Course	CY	1,550
Drainage Swale	LF	3,350
Site Security	MAN-HRS	5,900
Provide Water	Thousand Gallons	2,000

* Note: These measurements are channel centerline lengths which are the estimated pay quantities. The linear feet of streambanks to be constructed are approximately double these quantities.

other items of work, and no separate compensation will be allowed unless specifically provided for elsewhere in the Contract Documents. Fertilizing, seeding and mulching shall be performed under a separate contract except for stream bank vegetation and any mulching which is used for erosion control. All stripped and stockpiled topsoil shall be replaced.

15. MAINTENANCE OF FENCES

All fences adjacent to any work site are to be maintained except where removal of fences is specified. Any fence removed or destroyed during the course of Contract shall be reinstalled or reconstructed in like kind at no cost to the Owner or landowner. The cost for this work shall be considered incidental and no additional compensation will be allowed.

16. TERMINATION OF WORK OR CONTRACT

Termination of the work or the Contract shall be in accordance with Article 15 of the General Conditions.

The Contractor agrees to make his cost records available to the extent necessary to determine the validity and amount of each item claimed.

Termination of a contract or portion thereof shall not relieve the Contractor of his contractual responsibilities for the work completed, nor shall it relieve the surety of its obligation for and concerning any just claim arising out of the work performed.

17. USE OF EXPLOSIVES

The use of explosives is prohibited.

18. UNDISCOVERED AND UNDOCUMENTED HISTORIC PROPERTIES

During construction activities, undiscovered and undocumented historic properties may be encountered. In such event, the Contractor will adhere to the following procedures:

(a) For all unknown and undocumented historic properties discovered during remedial activities, the Owner's Representative will stop construction activities in the immediate area of the find to the extent such stoppage will not create an undue risk of harm to human health or the environment and notify the Owner. The Owner will then direct the Community Historic Preservation Officer, a qualified historian, or an archaeologist to examine the find, verify its significance, and conduct preliminary recordation, as necessary.

Within a maximum of four hours of the identification of a historic property judged to be significant, all participating parties to this contract will be notified. This will include all parties to the Second Programmatic Agreement Regarding Implementation of the CERCLA Related Elements of the Upper Clark Fork Basin Regional Historic Preservation Plan (2ndPA) (EPA, 1994) and interested tribal authorities. A representative of the State Historical Preservation Office (SHPO) shall visit the discovery within at least one business day to recommend how the historic property should be treated. Options include avoidance, mitigation on-site, mitigation off-site, or additional recordation.

(b) Within one business day, the Owner will consider the findings of the EPA, parties to the 2ndPA, tribal authorities, the Community Historic Preservation Officer or archeologist/historian, and the recommendations of SHPO and make a final determination on actions to be taken. The Owner will consult with all parties involved in the construction activities and SHPO before finalizing their decision. All decisions will be documented to the parties to this contract by the Owner and become part of the record. All Owner decisions are final, pursuant to Superfund authority.

19. ORDER OF WORK

This section presents a suggested order of work. Many of the work items can be accomplished simultaneously. This suggested order of work is intended as a guideline for the Contractor and may be changed during the development of the construction schedule.

It is expected that work will occur in two seasons separated by a winter shut-down. The following items are expected to be accomplished in the first construction season:

- Construction of Haul Roads
- Preparation of MWRR 2
- Preparation of Borrow Area
- Construction of Diversion Channel and Diversion Structure
- Excavation of Instream Sediments and Channel Corridor from Station 2+10 to 12+00
- Construction of Non-Deformable Stream Channel
- Excavation of Tailings/Impacted Soils between the Interstate Bridges
- Placing Backfill between the Interstate Bridges
- Construction of Site Fencing

The following is the suggested order of work:

1. Mobilize equipment to the site and establish staging areas and a decontamination area. Set up office and support facilities. Commence installation of erosion control measures.

2. Commence clearing, grubbing, and removing and disposing debris from all areas to be disturbed during the project. The first priority is MWRR 2. Next priorities are the haul roads and the floodplain.

3. Construct permanent fence around the Reach A floodplain, including Contractor staging areas.

4. Strip and stockpile topsoil in MWRR 2 in preparation for delivery of tailings/impacted soils and the lime amendment material. Construct temporary run-on control ditches.

5. Construct the haul road for transporting tailings/impacted soils from the Reach A floodplain to MWRR 2. Construct the approach ramps to the railroad crossing near MWRR 2. Rarus Railway Company will construct the track crossing. Install traffic signs and provide traffic controls at the county road crossing.

6. Commence excavation of the diversion channel, starting at the downstream end. Unsaturated tailings/impacted soils are to be excavated and hauled directly to MWRR 2. Saturated tailings/impacted soils are to be stockpiled and drained on site before delivery to MWRR 2. Non-impacted excavated material is to be used for compacted berms adjacent to the diversion channel.

7. Construct the diversion channel outflow grade control.

8. Place riprap in the diversion channel. Construct haul road crossings across the diversion channel.

9. Install the culvert crossing for the diversion channel at the county road.

10. Commence construction of groundwater dewatering sediment ponds.

11. Commence installation of sump pumps and excavation of dewatering trenches. Trench construction shall be done sequentially for each sediment pond. Construction shall start at the down-gradient end and proceed up-gradient for each trench. Discharge from the sumps shall be directed to the sediment ponds until construction is completed, the discharge water is clear (relatively free from sediment), and the Owner's Representative approves discharging directly to the completed diversion channel. Unsaturated tailings/impacted soils are to be excavated and

hauled directly to MWRR 2. Saturated tailings/impacted soils are to be stockpiled and drained on site before delivery to MWRR 2. Non-impacted material excavated from the trenches is to be separated from any tailings/impacted soils. Instream sediments from the existing stream channel are to be excavated and hauled to MWRR 2. Saturated instream sediments are to be dewatered on site before delivery to MWRR 2.

12. Conduct excavation of instream sediments from the existing stream channel between the Interstate 90 bridges, upstream of reconstructed channel station 12+00. Install coffer dams and dewater portions of channel. Instream sediments are to be stockpiled and drained on site before delivery to MWRR 2. Construct bed and banks within this section of channel. Repeat for successive channel sections.

13. Commence excavation of the tailings/impacted soils from the floodplain in the area between the Interstate 90 bridges. Unsaturated tailings/impacted soils are to be excavated and hauled directly to MWRR 2. Saturated tailings/impacted soils are to be stockpiled and drained on site before delivery to MWRR 2.

14. Commence placement and lime treatment of the tailings/impacted soils in MWRR 2. Treated material is to be spread and compacted.

15. Temporarily divert Silver Bow Creek into the diversion channel at Station D2+00 using temporary flow barrier.

16. Construct the diversion headworks structure.

17. Remove temporary flow barrier and divert Silver Bow Creek into the diversion channel.

18. Clear, grub, remove debris, and strip and stockpile topsoil from Borrow Area 10.

19. Remove impacted soils from haul roads and dispose in MWRR 2.

20. Construct the haul road from Reach A to Borrow Area 10. Construct the stream crossings east and west of Rocker. Construct the approach ramps to the railroad crossing west of Rocker. Rarus Railway Company will construct the track crossing. Install traffic signs and provide traffic controls at the county road crossing just east of Rocker and at the road easement at Borrow Area 10.

21. Commence excavation of the tailings/impacted soils from the floodplain downstream from the Interstate 90 bridges. Most of the material will be unsaturated due to groundwater dewatering efforts and will be excavated and hauled directly to MWRR 2. Some areas of saturated tailings/impacted soils may be encountered, in which case they are to be stockpiled and drained on site before delivery to MWRR 2.

22. Excavate and haul designated railroad waste materials from existing railroad embankments to MWRR 2.

23. Place rock cover on designated railroad waste material areas.

24. Construct railroad materials sediment basin S-1.

25. Commence construction of the reconstructed channel corridor downstream of Station 14+00. Reshape the corridor by moving and placing non-impacted, excavated material within the reconstructed floodplain.

26. Commence excavation, hauling, placing, and compacting floodplain backfill material from Borrow Area 10 to the Reach A floodplain.

27. Recontour the floodplain to accommodate construction of the Greenway Trail base and drainage swale.

28. Commence construction of the new streambed and bank treatments for both pool and riffle areas.

29. Remove the existing county road culvert and construct the new culvert crossing. This task should be completed before channel reconstruction is performed in this reach.

30. Deactivate groundwater dewatering systems as stream channel construction proceeds downstream. Backfill trenches with the non-impacted excavated material and final contour with material from Borrow Area 10. Reclaim sediment ponds to original contours.

31. After all tailings/impacted soils, instream sediments, and railroad waste materials have been transported, treated, and placed in MWRR 2, construct the soil cap. Construct the permanent run-on control ditches. Reclaim the disturbed ground and the haul road at MWRR 2.

32. Construct railroad materials sediment basins S-2 and S-3. Incorporate the run-on ditches from MWRR 2.

33. Reclaim the haul roads in the vicinity of Reach A. Remove the haul road crossings across the diversion channel. Remove the railroad crossing near MWRR 2. Haul roads and stream crossings located between Reach A and Borrow Area 10 will remain for future remedial action efforts. Public road and railroad crossings will be temporarily deactivated.

34. After all floodplain backfill material has been placed and the MWRR 2 soil cap has been constructed, conduct final grading in Borrow Area 10.

35. Construct fences around the railroad materials sediment basins and MWRR 2.

36. Decontaminate all equipment and demobilize from the site.

20. SUBMITTALS

All shop drawings, samples and other submittals required by the contract shall be submitted in accordance with Paragraph 6.17 of the General Conditions. As an aid to the Contractor the following submittals will be required. This list is not considered to be exhaustive and additional submittals may be requested by the Owner or Owner's Representative.

1. Construction Schedule, List of Subcontractors and Schedule of Values. Submit within five days after Notice to Proceed.

2. List of Employees, Job Classifications, and current OSHA 29 CFR 1910.120 certificates for all site workers. Submit at Preconstruction Conference.

3. Health and Safety Plan. Submit at least three days prior to the start of construction.

4. Transportation Plan. Submit at least 10 days prior to start at construction.

5. Erosion Control Plan. Submit at least 10 days prior to the start of construction.

6. Contractor Quality Control Plan. Submit at least 10 days prior to the start of construction.

7. Waste Amendment and Placement Plan. Submit at least 10 days prior to the start of placement of mine waste.

8. Construction material certifications shall be submitted as required in these Special Provisions and the Technical Specifications. Certifications shall be submitted at least 14 days prior to installation.

9. Reconstructed channel and diversion system dewatering system plan (see Technical Specifications Subsection 545.01E). Submit at least 10 days prior to start of construction on the diversion system.

10. Cofferdam placement and operations plan (see Technical Specifications Subsection 545.01E). This shall include an operating plan for flows ranging from 0 to 30 cfs, and an evacuation plan for flows up to 2,330 cfs (100-year flow) in Silver Bow Creek. Submit at least 10 days prior to start of cofferdam placement.

11. Payroll Record - Submit weekly.

12. Project Close Out - Refer to Supplementary Conditions, Part 1, Paragraph 14.2.

21. MEASUREMENT AND PAYMENT

(A) **General:** The project contract has lump sum prices for: Mobilization, Demobilization, Bonding and Insurance (Bid Item No. 1); Clearing and Grubbing (Bid Item No. 2); Haul Roads (Bid Item No. 4); Diversion System (Bid Item No. 9); MWRR 2 Preparation (Bid Item No. 10); MWRR 2 Soil Cap (Bid Item No. 12); County Road Culvert Crossing (Bid Item No.17); and Railroad Materials Remediation Sediment Basins (Bid Item No. 20).

This project contract has unit prices for: Debris Disposal (Bid Item No. 3); Traffic Control (Bid Item No. 5); Groundwater Dewatering (Bid Item No. 6); Tailings/Impacted Soils Excavation and Hauling to MWRR 2 (Bid Item No. 7); In-Stream Sediment Excavation and Hauling to MWRR 2 (Bid Item No. 8); MWRR 2 Soil Lime Treatment, Placement, and Compaction (Bid Item No. 11); Stream Channel Corridor Construction (Bid item No. 13); Deformable Channel Reconstruction: Pool Sections (Bid Item No. 14); Deformable Channel Reconstruction: Riffle Sections (Bid Item No. 15); Organic Soil Amendment (Bid Item No. 16); Non-Deformable Stream Channel Reconstruction (Bid Item No. 18); Railroad Materials Remediation Rock Cover (Bid Item No. 19); Excavation and Placement of Non-Impacted Floodplain Materials (Bid Item No. 21); Borrow Area 10 Preparation and Final Grading (Bid Item No. 22); Borrow Area 10 Excavation, Hauling, and Placing Floodplain Backfill (Bid Item No. 23); Farm Fence (Bid Item No. 24); Combination Fence (Bid Item No. 25); Pole Fence (Bid Item No. 26); Site Security (Bid Item No. 27); Provide Water (Bid Item No. 28); Greenway Trail Base (Bid Item No. 29); and Drainage Swale (Bid Item No. 30).

The total price for each item of the contract shall cover all work shown on the contract drawings and required by the specifications and other Contract Documents. All costs in connection with the work, including furnishing all materials, equipment, supplies, and appurtenances; providing all construction equipment, tools, incidents; and performing all necessary labor and supervision to fully complete the work, shall be included in the unit and lump sum prices bid. No item that is required by the Contract Documents for the proper and successful completion of the work will be paid for outside or in addition to the prices submitted in the bid.

All work not specifically set forth as a pay item in the Proposal shall be considered a subsidiary obligation of the Contractor and all costs in connection therewith shall be included in the prices bid.

Unauthorized excavation shall be backfilled in accordance with the appropriate specifications at the Contractor's expense. Unauthorized excavation consists of removal of materials beyond the indicated subgrade elevations or dimensions without specific direction of the Owner's Representative.

(B) **Estimated Quantities:** All estimated quantities stipulated in the Proposal or other Contract documents are approximate and are to be used only (a) as a basis for estimating the probable cost of the work and (b) for the purpose of comparing the bids submitted for the work. The actual amounts of work done and materials furnished under unit price items may differ from the estimated quantities. The basis of payment for work and materials for Unit Price Work will be the actual amount of work done and materials furnished. The Contractor agrees that he will make no claim for damages, anticipated profits, or otherwise on account of any difference between the amount of work actually performed and materials actually furnished and the estimated amounts herein. The Unit Price of an

item of Unit Price Work shall be subject to re-evaluation and upward or downward adjustment in accordance with Paragraph 11.03 of the General Conditions.

Lump Sum bid items based upon estimated quantities are not subject to adjustment for actual quantities. The Lump Sum price reflects a reasonable compromise of Owner's and Contractor's risk that the actual quantity of material may be higher or lower than the estimate.

All estimated quantities designated as Cubic Yard shall be considered Bank Cubic Yards unless otherwise noted. Excavated "bank" cubic yards is the quantity of material removed as measured in its original position.

(C) **Incidentals:** The following measurement and payment sections do not necessarily name all the incidental items required by the Contract Documents to complete the work. The cost of all such incidentals shall be included in the various related bid items. Final payment will not be made until all of the work is complete.

(D) **Mobilization, Demobilization, Bonding and Insurance (Bid Item No. 1):**

General: This item shall consist of the preparatory work and operations necessary for the movement of personnel, equipment, supplies, and incidentals to the work site. The work includes the preparation and movement of all buildings and equipment for on-site facilities and Contractor offices, and cleaning of equipment to prevent importation of noxious weeds. This item includes demobilization and all incidentals required for staging area preparation, decontamination zone preparation, and site cleanup.

It is expected that work will occur during two construction seasons and mobilization and demobilization charges for each construction season should be included in this item. This item includes all materials, equipment and personnel required by the Contractor for security of Contractor equipment and materials. It does not include general site security required by the Owner which is a separate item. This item also includes a trailer equipped to the specifications listed in Technical Specification Subsection 510.00, Owner's Field Office.

The Contractor's cost for administration, bonding, insurance, and site documents shall be included in mobilization and shall not be paid as a separate item.

Work Included:

- Mobilize to the site and demobilize from the site with all necessary equipment to complete the work
- Clean equipment to prevent importation of noxious weeds
- Obtain necessary permits
- Insurance and bonding for the contract
- Mobilization and demobilization costs for subcontracted work
- Construct and reclaim access, staging, and decontamination areas
- Construct and install erosion control measures for access, staging, and decontamination areas
- Provide Contractor site security for staging areas
- Provide an Owner's Representative Field Office
- Repair of any property damage done by the Contractor
- Provide all labor, tools, equipment, materials, and incidentals necessary to complete the work as specified.

Measurement: No measurement of this item will be made.

Payment: Fifty percent payment for this item will be allowed once the Contractor has submitted bond and insurance certificates, is fully mobilized and has forwarded all submittals for approval. Full payment for this item will be allowed once the Contractor has completed the work for the remainder of the contract, completed final clean up work, and has fully demobilized equipment and materials from the site. Payment will be based on the total lump sum amount bid as shown in the Bid Proposal of the Contract Documents. The bid price for this item must not exceed 10 percent (%) of the total bid price.

(E) **Clearing and Grubbing (Bid Item No. 2):**

General: This work consists of clearing, grubbing, shredding, and chipping woody vegetation within the areas disturbed by construction operations for the diversion channel, new channel excavation, MWRR 2, borrow areas, haul roads, and tailings excavation areas according to Technical Specification 201.00.

Work Included:

- Clear and grub woody vegetation
- Remove tree, willow, and shrub root balls
- Shred and chip the limbs and stems of all woody vegetation including willows, aspens, sagebrush, and other woody shrubs.
- Remove soil from all stumps and root balls prior to disposal
- Stockpile shredded and chipped vegetation for later use
- Provide all labor, tools, equipment, materials, and incidentals necessary to complete the work as specified

Measurement: No measurement of this item will be made.

Payment: Partial payment for clearing and grubbing operations will be allowed based on the estimated fraction of work completed. Payment will be made according to the total lump sum amount bid as shown in the Bid Proposal of the Contract Documents.

(F) **Debris Disposal (Bid Item No. 3):**

General: This work consists of removing debris and trash from areas disturbed by construction activities including the diversion channel, new channel excavation, MWRR 2, borrow areas, haul roads, and tailings excavation areas. Debris and trash will be separated as described in the Special Provisions and disposed in a licensed Class III landfill.

Work Included:

- Separate debris into disposal classes
- Remove excess soil from treated and untreated timbers by dislodging
- Remove the majority of soil from demolition debris and trash to reduce the volume of soil to an acceptable level as approved by the Owner's Representative
- Disposal of root balls, treated and untreated timbers, rubber tires, fence posts, fence wire, scrap metal, trash, and other debris in approved disposal facility
- Provide all labor, tools, equipment, materials, and incidentals necessary to complete the work as specified.

Measurement: This item will be measured by the number of cubic yards delivered and disposed at the licensed disposal facility. Proof of cubic yardage will be accepted in the form a delivery ticket obtained from the disposal facility showing the number of cubic yards accepted for disposal.

Payment: Payment will be made based on the cubic yardage accepted by the disposal facility. Proof of the quantity disposed must be submitted to the Owner's Representative for review before approval for payment is granted. Payment will be made according to the unit price bid as shown in the Bid Proposal of the Contract Documents.

(G) **Haul Roads (Bid Item No. 4):**

General: This item includes preparation of a Transportation Plan and the construction of haul roads for all construction activities of this project. This bid item includes construction of stream, utility, and public road crossings. It includes approaches for railroad crossings. It also includes construction and removal of crossings in the diversion channel. The Contractor will determine the number of diversion channel crossings needed for the project. Locations for the diversion channel crossings will be subject to approval by the Owner's Representative. Reclamation of the haul roads within Reach A

and the haul road that accesses MWRR 2 is included in this bid item. This work item includes maintenance of the haul roads and secondary haul road construction. Surveying and haul road alignment for this item will be the responsibility of the Contractor except for surveying for excavation of tailings/impacted soils which will be the responsibility of the Owner's Representative. Rarus Railway will construct the railroad crossings, but the Contractor will construct approaches to the crossings.

Work Included:

- Preparation of a Transportation Plan (including a Traffic Control Plan)
- Surveying lines and grades of primary haul roads and all crossings
- Haul road construction
- County road crossings and approaches
- Stream crossings construction
- Railroad crossing approaches
- Control of access on Highway 10
- Reclaiming haul roads within Reach A and the haul road that accesses MWRR 2
- Installation and removal of diversion channel crossings, and
- Provide all labor, tools, equipment, materials, and incidentals necessary to complete the work as specified.

Measurement: No measurement of this item will be made.

Payment: Ninety percent (90%) payment of this item will be made after haul road construction, including installation of stream crossings, utility crossings, county road crossings, railroad crossing approaches, and diversion channel crossings, is complete to the satisfaction of the Owner's Representative. The ten percent (10%) remaining payment will be made after reclamation of the haul road within Reach A, the haul road that accesses MWRR 2, and removal of the diversion channel crossings. Payment percentages will be made according to the total lump sum amount bid as shown in the Bid Proposal of the Contract Documents.

(H) **Traffic Control (Bid Item No. 5):**

General: This item includes providing all personnel, equipment, and signage for control of traffic on primary and secondary haul roads, and public roads, affected by construction traffic. Contractor will provide flaggers for the railroad crossings.

Work Included:

- Providing flaggers for the railroad crossings.
- Providing flaggers for the county road crossing.
- Providing all necessary personnel, equipment, and signage
- Provide all labor, tools, equipment, materials, and incidentals necessary to complete the work as specified.

Measurement: This item will be measured by the total number of man-hours that flag persons are provided at the county road crossing. The unit of payment shall be the man-hour.

Payment: Payment will be made based on the number of man-hours traffic control is utilized, as approved by the Owner's Representative. Traffic control will be paid according to the unit price bid in the Bid Proposal of the Contract Documents.

(I) **Groundwater Dewatering (Bid Item No. 6):**

General: Groundwater dewatering consists of the construction, maintenance, and safety fencing of trenches and sumps to the lines and elevations as shown on the Drawings. The work also includes construction and maintenance of sediment detention ponds and the associated piping systems constructed in the general locations and to the specific sizes shown on the drawings.

Work Included:

- Trench and sump excavation and stockpiling of salvaged non-impacted soil. Excavation of tailings/impacted soils is part of bid item no. 7, Tailings/Impacted Soils Excavation and Hauling to MWRR 2.
- Installing and maintaining safety fence and other safety requirements (OSHA)
- Providing all power, pumps, piping, fittings, and other appurtenances necessary to operate and maintain the dewatering system
- Maintenance of the dewatering system to ensure its continuous operation including providing a backup system
- Quality control testing of compacted fill
- Construction and maintenance of sediment basins
- Closure of dewatering trenches and sediment basins after construction is complete
- Provide all labor, tools, equipment, materials, and incidentals necessary to complete the work as specified.

Measurement: Measurement shall be by the linear foot of dewatering trench constructed.

Payment: Payment will be made as the work is completed and approved by the Owner's Representative. Payment will be based on the unit price in the Bid Proposal of the Contract Documents.

(J) **Tailings/Impacted Soils Excavation and Hauling to MWRR 2 (Bid Item No. 7):**

General: This item consists of excavating tailings/impacted soils to the lines shown on the construction drawings and hauling tailings/impacted soils to MWRR 2.

Work Included:

- Excavation of tailings/impacted soils from areas under haul roads, the diversion channel, and dewatering trenches
- Erosion control
- Abandonment of four existing monitoring wells between the Interstate 90/15 bridges
- Stockpiling excessively wet materials in the floodplain in accordance with the moisture requirements for transporting materials without loss
- General removal of tailings/impacted soils from the floodplain of Reach A.
- Hauling tailings/impacted soils to MWRR 2 and unloading in designated areas
- Provide dust control for excavation areas and haul roads
- Provide all labor, tools, equipment, materials, and incidentals necessary to complete the work as specified.

Measurement: Measurement of this work item will be made according to the computed number of bank cubic yards to be excavated from the floodplain area. The quantity measurement and calculation will be made by the Owner's Representative. The Owner's Representative shall multiply the staked cut at each 50-foot grid point by 2,500 square feet, sum the volumes for all cut stakes within the horizontal extent of tailings, and divide by 27 to convert to cubic yards. Cuts not on the grid (i.e., at the horizontal extent line) will not be included in the calculation. The Owner's Representative shall provide a record of all cuts included in the calculation in electronic format for independent verification of the volume by the Contractor. No allowance shall be made for actual cuts as opposed to staked cuts. The sum total of intermediate payment quantities will be subtracted from the final payment quantity for payment in the final pay request for this item.

Payment: Payment will be made as the work is completed and approved by the Owner's Representative. Excavation and transport of tailings/impacted soils to MWRR 2 will be paid according to the unit price shown in the Bid Proposal of the Contract Documents.

(K) **In-Stream Sediment Excavation and Hauling to MWRR 2 (Bid Item No. 8):**

General: This item includes excavation of contaminated in-stream sediments, stockpiling and draining saturated sediments, and hauling of dewatered sediments to MWRR 2.

Work Included:

- Excavation of in-stream sediments at the locations shown on the plan sheets.
- Stockpiling excessively wet materials in the floodplain in accordance with the moisture requirements for transporting materials without loss
- Transport of in-stream sediments to MWRR 2
- Provide all labor, tools, equipment, materials, and incidentals necessary to complete the work as specified.

Measurement: In-stream sediment removal shall be paid by the computed bank cubic yard. Removal volumes shall be determined by measuring the removal area, multiplying it by one foot depth, and dividing by 27 to obtain cubic yards. No allowance shall be made for actual cuts as opposed to measured and computed cuts.

Payment: Payment will be made as the work is completed and approved by the Owner's Representative. Excavation and transport of in-stream sediments to MWRR 2 will be paid according to the unit price shown in the Bid Proposal of the Contract Documents.

(L) **Diversion System (Bid Item No. 9):**

General: This item includes supplying all materials, equipment, labor and incidentals to construct a diversion structure, diversion channel, and a diversion channel outfall. Work under this item shall provide for incidental dewatering during construction. Silver Bow Creek is to be diverted by the diversion structure into the diversion channel. This pay item shall also include maintenance of the diversion system during the contract period. The diversion system shall remain in place at the completion of the contract and for a period of years thereafter.

Work Included:

- Diversion channel excavation and levee construction
- Diversion channel lining (stone)
- Construction of diversion channel outfall, including grade control
- Construction of grade control structure on existing stream channel at diversion channel tie-in
- Diversion structure berm and spillway construction
- Diversion culverts and headworks construction
- Incidental dewatering
- Provide all labor, tools, equipment, materials, and incidentals necessary to complete the Work as specified.

Measurement: No measurement for this pay item will be made.

Payment: Partial payment for diversion channel construction and maintenance will be allowed based on the estimated fraction of work completed. Payment will be made according to the total lump sum amount bid as shown in the Bid Proposal of the Contract Documents.

(M) **MWRR 2 Preparation (Bid Item No. 10):**

General: This item consists of stripping the top six (6) inches of topsoil from the footprint of MWRR 2 and associated disturbance areas as shown on the plans and stockpiling the topsoil in the areas designated. No areas outside the disturbance area indicated on the Drawings shall be disturbed unless approved by the Owner's Representative in writing. Temporary run-on control, construction of the runoff ditches east and south of the repository, and construction of two construction sediment ponds are also included in this item. Clearing and grubbing and debris disposal are included in Bid Items No. 2, Clearing and Grubbing, and No. 3, Debris Disposal.

Work Included:

- Stripping the top six (6) inches of topsoil
- Stockpiling the topsoil on site
- Initiating construction of the haul road within the MWRR 2 boundary
- Constructing temporary run-on control
- Constructing the runoff ditches east and south of the repository.
- Constructing two (2) construction sediment ponds.
- Constructing a new drainage channel on the east side of the repository.
- Provide erosion control
- Place culverts
- Provide all labor, tools, equipment, materials, and incidentals necessary to complete the work as specified.

Measurement: No measurement for this pay item will be made.

Payment: This item will be paid for when work is complete to the satisfaction of the Owner's Representative. Payment will be made according to the total lump sum amount bid as shown in the Bid Proposal of the Contract Documents.

(N) **MWRR 2 Soil Lime Treatment, Placement and Compaction (Bid Item No. 11):**

General: This item includes mixing lime with the tailings/impacted soil, in-stream sediments, and railroad materials at the rates specified on the drawings or special provisions, and spreading and compacting treated material according to the specifications provided in the Special Provisions.

Work Included:

- Completing amendment mixing tests and plan for waste amendment
- Drying tailings/impacted soils to required moisture content.
- Applying the lime at the specified rates and mixing the lime with the waste materials
- Compacting the waste in accordance with the specifications.
- Additional construction of the haul road in stages within the MWRR 2 boundary.
- Grading the top of the compacted waste in accordance with the lines and grades on the drawings
- Cover and straw mulch repository for winter shut-down
- Material testing services
- Provide all labor, tools, equipment, materials, and incidentals necessary to complete the work as specified.

Measurement: The volume of the graded waste shall be measured after incorporation of lime and the amended waste has been compacted in place. Volume units shall be cubic yards. The Owner's Representative will survey the base area of the waste pile after stripping of topsoil and the finished grade of the waste pile after placement, compaction and final grading. The survey shall be conducted on a 50 foot grid or other appropriate method. Copies of the survey measurements and computations shall be provided to the Contractor for verification of the volume.

Payment: Partial payments may be based on volume of materials (excluding lime materials) transported to the MWRR 2 and treated, mixed, and compacted in accordance with the specifications. Partial payment volumes shall be based on bank cubic yards of the materials at their place of origin. Final payment shall be based on the surveyed volume of compacted material measured in-place. MWRR 2 Soil Lime Treatment, Placement and Compaction will be paid according to the unit price contained in the Contract Documents.

(O) **MWRR 2 Soil Cap (Bid Item No. 12):**

General: The work for this item includes respreading salvaged topsoil and constructing a soil cap on MWRR 2 to the depths shown on the drawings and other site work required to complete construction of MWRR 2.

Work Included:

- Replace and compact topsoil on top of lime-treated material
- Replace topsoil on disturbed areas
- Excavate and haul borrow material from borrow areas
- Place and compact borrow material
- Grading cover soil and salvaged topsoil
- Recontouring the haul road and eliminating the runoff ditch east of the repository.
- Materials testing services
- Constructing final run-on ditches
- Provide all labor, tools, equipment, materials, and incidentals necessary to complete the work as specified.

Measurement: No measurement for this pay item will be made.

Payment: This item will be paid for when work is complete to the satisfaction of the Owner's Representative. Payment will be made according to the total lump sum amount bid as shown in the Bid Proposal of the Contract Documents.

(P) **Reconstructed Channel Corridor Construction (Bid Item No. 13):**

General: Work for this item shall include, but is not necessarily limited to, excavation of the reconstructed channel corridor from Stations 2+10 to 4+05, Stations 4+45 to 8+30, Stations 9+40 to 12+00, and Stations 14+00 to 69+50, and incidental dewatering. Excavated, non-impacted floodplain material (i.e., below the base of tailings/impacted soils level) may be placed adjacent to the reconstructed channel corridor, as necessary, as part of floodplain remediation. Removal of tailings/impacted soils is not part of this item but is covered by Bid Item No. 7, Tailings/Impacted Soils Excavation and Hauling to MWRR 2. Excavation of in-stream sediment is not part of this item but is covered by Bid Item No. 8, In-Stream Sediment Excavation and Hauling to MWRR 2.

Work Included:

- Excavation of reconstructed channel corridor in non-impacted floodplain material below the designated base of tailings
- Placement of non-impacted floodplain material
- Provide all labor, tools, equipment, materials, and incidentals necessary to complete the Work as specified.

Measurement: Measurement of this item shall be by the bank cubic yard of excavated material. During staking of the channel cross-sections, existing ground surface elevations shall be determined at each section. Channel corridor volume shall be computed by the end-area method calculating the area between existing ground and the designated grade of the over-excavated channel. The volume of any in-stream sediments removed during channel corridor excavation shall be subtracted from this volume calculation. Excavation of tailings/impacted soils (Bid Item No. 7) and excavation for dewatering trenches shall not be included in this calculation. The Owner's Representative will be responsible for verification of quantities.

Payment: Payment shall be by the volume of excavated material in bank cubic yards. Final payment will be made after review of the Contractor's volume calculations by the Owner's Representative. Excavation of the reconstructed channel and placement of the excavated non-impacted material in the floodplain will be paid according to the unit price contained in the Contract Documents.

(Q) **Deformable Channel Reconstruction: Pool Sections (Bid Item No. 14):**

General: This work item includes placement of streambed material, placement and compaction of streambank subsoil, placement and compaction of cover soil, and installation of coir fabric material in channel pool sections between Stations 14+00 and 69+50.

Work Included:

- Placement and compaction of streambed material
- Placement and compaction of streambank subsoil
- Placement and compaction of cover soil
- Installation of seed and coir fabric material and materials testing
- Provide all labor, tools, equipment, materials, and incidentals necessary to complete the Work as specified.

Measurement: Measurement of this item shall be by the linear foot of Deformable Channel Reconstruction: Pool Sections, measured along the channel centerline and constructed in conformity with the Drawings and Specifications or as directed by the Owner's Representative. Note that linear feet of streambank construction is approximately double the channel centerline measurement.

Payment: Payment will be made based on the amount bid per linear foot of Deformable Channel Reconstruction: Pool Sections, as shown in the Bid Proposal of the Contract Documents.

(R) **Deformable Channel Reconstruction: Riffle Sections (Bid Item No. 15):**

General: This work item includes placement of streambed material, placement and compaction of streambank subsoil, placement of cover soil, and installation of coir fabric material in channel riffle sections between Stations 14+00 and 69+50.

Work Included:

Representative and the ordinances and codes of government agencies regarding signs, traffic, fires, explosives, danger signals and barricades.

- Placement and compaction of streambed material
- Placement and compaction of streambank subsoil
- Placement and compaction of cover soil
- Installation of seed and coir fabric material
- Provide all labor, tools, equipment, materials, and incidentals necessary to complete the Work as specified.

Measurement: Measurement of this item shall be by the linear foot of Deformable Channel Reconstruction: Riffle Sections, measured along the channel centerline and constructed in conformity with the Drawings and Specifications or as directed by the Owner's Representative. Note that linear feet of streambank construction is approximately double the channel centerline measurement.

Payment: Payment will be made based on the amount bid per linear foot of Deformable Channel Reconstruction: Riffle Sections, as shown in the Bid Proposal of the Contract Documents.

(S) **Organic Matter (Bid Item No. 16):**

General: This work item includes furnishing and uniformly incorporating an organic soil amendment (compost) into cover soils, as necessary, to meet the specified organic matter requirement.

Work Included:

- Obtain organic soil amendment (compost) that contains sufficient organic matter (on a dry weight basis) such that amended cover soil meets the specified organic matter content
- Uniformly incorporate the compost into the cover soil

- Provide all labor, tools, equipment, materials, and incidentals necessary to complete the work as specified.

Measurement: Measurement for this item shall be based on the surface area of cover soil after application and incorporation of the organic amendment. The surface area of the amended cover soil will be multiplied by the application depth to determine the total volume of amended cover soil in-place. The quantity (tons) of organic matter applied will be determined based on the required percentage of organic matter in the cover soil. Calculations shall be performed as shown in Technical Specifications Subsection 315.03.

Payment: Payment will be made based on the number of tons of organic matter (on a dry weight basis) applied to meet the specified organic matter content of the cover soil. Note that tons of organic matter is calculated based on test results and is different than tons of compost. Payment will be made based on the unit price bid per ton of organic matter, as shown in the Bid Proposal of the Contract Documents.

(T) **County Road Culvert Crossing (Bid Item No. 17):**

General: This item includes all work necessary to install two culvert crossings at the existing county road, one for the reconstructed channel and one for the diversion channel. All culvert bedding materials, culvert headwall materials, embankment material, and road base and surface course materials shall be considered a part of the road crossing construction. Materials and specific grading requirements for stilling basin construction at the culvert outfalls are not a part of this item, but are included as part of the Diversion System (Bid Item No. 9).

Work Included:

- Installation of culverts, including bedding materials
- Installation of culvert cutoff/headwalls
- Reconstruction of road prism
- Removal of existing culverts
- Provide all labor, tools, equipment, materials, and incidentals necessary to complete the Work as specified.

Measurement: No measurement shall be made for this item.

Payment: Fifty percent payment shall be made upon completion of installation of one culvert and restoration of road service. Remaining payment will be allowed once the Contractor has completed this work item and to the satisfaction of the Owner's Representative. Payment will be made according to the total lump sum amount bid as shown in the Bid Proposal of the Contract Documents.

(U) **Non-Deformable Stream Channel Reconstruction (Bid Item No. 18):**

General: This work item includes placement of a cofferdam dewatering system, incidental dewatering, excavation of channel and streambank materials, placement of streambed material, placement of streambank toe material (stone), placement of upper bank subsoil, placement of cover soil, and installation of seed and coir fabric material between Stations 2+10 and 4+05, Stations 4+45 and 8+30, and Stations 9+40 and 12+00. Excavation of in-stream sediment is not part of this item but is covered by Bid Item No. 8, In-Stream Sediment Excavation and Hauling to MWRR 2.

Work Included:

- Placement of cofferdam and dewatering
- Excavation of channel and streambank material
- Placement of bank toe stone
- Placement of outer and inner coir fabric
- Placement and compaction of streambank subsoil
- Placement and compaction of cover soil
- Installation of seed and coir fabric material

- Provide all labor, tools, equipment, materials, and incidentals necessary to complete the work as specified.

Measurement: Measurement of this item shall be by the linear foot of Non-Deformable Channel Reconstruction, measured along the channel centerline and constructed in conformity with the Drawings and Specifications or as directed by the Owner's Representative. Note that linear feet of streambank construction is approximately double the channel centerline measurement.

Payment: Payment will be made based on the amount bid per linear foot of Non-Deformable Channel Reconstruction, as shown in the Bid Proposal of the Contract Documents.

(V) **Railroad Materials Remediation Rock Cover (Bid Item No. 19):**

General: This item shall consist of placing a rock material cover over railroad embankment waste material areas. The work also consists of excavating waste material from railroad embankments and hauling the material to MWRR 2.

Work Included:

- Excavating waste material from railroad embankments and hauling the material to MWRR 2
- Placing a rock material cover over railroad embankment waste material areas
- Provide all labor, tools, equipment, materials, and incidentals necessary to complete the Work as specified.

Measurement: Measurement of this work item will be made according to the number of cubic yards of rock placed in the railroad embankments to the satisfaction of the Owner's Representative, as measured and calculated by the Owner's Representative. The covered areas will be measured in square feet of area of rock placed multiplied by a nominal thickness of 0.8 feet and this result converted to cubic yards. A copy of the Owner's Representative's volume computations will be delivered to the Contractor for review prior to payment.

Payment: Payment will be made on the number of cubic yards of rock placed after approval of the quantity calculations by the Contractor. Rock cover will be paid according to the unit price shown in the Bid Proposal contained in the Contract Documents.

(W) **Railroad Materials Remediation Sediment Basins (Bid Item No. 20):**

General: This item includes work to construct three (3) sediment basins for the detention of sediment from railroad waste embankments outside of the Operable Unit as shown on the Drawings. Construction staking will be performed by the Owner's Representative. Reference points for horizontal locations are provided on the Drawings. Horizontal and vertical control shall be from the control points shown on the Drawings.

Work Included:

- Temporary diversion of stream flows at Sediment Basin S-1
- Stripping and temporary stockpiling of the top six (6) inches of topsoil
- Excavation of native material for the basins
- Abandonment of an existing monitoring well at Basin S-1
- Placement of fill and compaction for berms
- Installation of outlet piping and anti-seepage collars
- Construction of spillways
- Placement of stone for erosion protection
- Replacement of salvaged topsoil on the berms and disturbed areas
- Provide all labor, tools, equipment, materials, and incidentals necessary to complete the work as specified.

Measurement: No measurement of this item will be made.

Payment: Partial payment for sediment basin construction will be allowed based on the estimated fraction of work completed. Payment will be made according to the total lump sum amount bid as shown in the Bid Proposal of the Contract Documents.

(X) **Excavation and Placement of Non-Impacted Floodplain Materials (Bid Item No. 21):**

General: This work item includes excavation and placement of non-impacted floodplain materials. Staking of the final grade will be conducted by the Owner's Representative.

Work Included:

- Excavation and placement of non-impacted floodplain materials
- Compaction of fill
- Provide all labor, tools, equipment, materials, and incidentals necessary to complete the Work as specified.

Measurement: Excavation and placement of non-impacted floodplain materials shall be measured by the bank cubic yard. The quantity measurement and calculation will be made by the Owner's Representative. The Owner's Representative shall stake final grade after tailings/impacted soils removal on a 50 foot grid according to the plans. The depth of excavation at each stake requiring a cut shall be multiplied by 2,500 square feet and all such cut volumes summed to obtain the volume in cubic feet which will then be converted to cubic yards. Only stakes at regular 50 foot grid points shall be included in the calculation. The Owner's Representative shall provide a record of all cuts included in the calculation in electronic format for independent verification of the volume by the Contractor.

Payment: Payment will be made on the number of bank cubic yards of cut material after approval of the Owner's Representative's quantity calculations by the Contractor. Excavation and Placement of Non-Impacted Floodplain Materials will be paid according to the unit price shown in the Bid Proposal contained in the Contract Documents.

(Y) **Borrow Area Preparation and Final Grading (Bid Item No. 22):**

General: This item consists of preparing the borrow area for excavation and final grading of the borrow area after excavation is complete. Preparation includes stripping the top six (6) inches of topsoil from the borrow area and stockpiling the topsoil in the area shown on the plans.

Work Included:

- Stripping the top six (6) inches of topsoil
- Stockpiling the topsoil on site
- Final grading and spreading of the stockpiled topsoil
- Provide all labor, tools, equipment, materials, and incidentals necessary to complete the Work as specified.

Measurement: The Owner's Representative will conduct a survey to determine the area in acres stripped of topsoil.

Payment: Payment of fifty percent (50%) of this pay item will be made after topsoil is stripped and stockpiled and approved by the Owner's Representative. The remaining fifty percent (50%) of this item shall be payed after final grading is completed and approved by the Owner's Representative. Borrow area preparation will be paid according to the unit price shown in the Bid Proposal of the Contract Documents.

(Z) **Borrow Area Excavation, Hauling, and Placing Floodplain Backfill (Bid Item No. 23):**

General: This item consists of excavation from the borrow area as designated by the Owner's Representative and as shown on the drawings, hauling to the floodplain, placement, and compaction of floodplain backfill materials.

Work Included:

- Excavation of backfill materials from designated borrow area
- Hauling material to the floodplain, including floodplain haul road crossings
- Placement and compaction of floodplain backfill
- Materials Testing
- Provide dust control for the borrow area and haul roads
- Provide all labor, tools, equipment, materials, and incidentals necessary to complete the Work as specified.

Measurement: Measurement of this work item will be made according to the number of placed and compacted cubic yards of backfill in the new floodplain. The quantity measurement and calculation will be made by the Owner's Representative. The method for measurement will consist of the following: the fill depths determined by the final grade survey conducted for Bid Item No. 20, Excavation and Placement of Non-impacted Floodplain Materials, shall be multiplied by 2,500 square feet for each 50 foot grid point. Only those points located on the regular 50 foot grid shall be included in the calculation. The sum of these fill volumes shall be divided by 27 to obtain a fill volume calculated in cubic yards compacted in place. The quantity of cut excavated and placed under Bid Item No. 20, shall be subtracted from this fill volume to obtain the payment quantity for excavation, hauling and placing backfill from Borrow Area 10. The sum total of intermediate payment quantities will be subtracted from the final payment quantity for payment in the final pay request for this item.

Payment: Payment will be made on the number of bank cubic yards of material placed as floodplain backfill after approval of the Owner's Representative's computations by the Contractor. Excavation, hauling, and placement of floodplain backfill will be paid according to the unit price shown in the Bid Proposal contained in the Contract Documents.

(AA) **Farm Fence (Bid Item No. 24):**

General: This work item includes construction of all Type F-5M or F-5W farm fence and gates.

Work Included:

- Install fence around the main work area and contractor's staging area
- Fence MWRR 2 and sediment basins adjacent to MWRR 2
- Installation of gates
- Provide all labor, tools, equipment, materials, and incidentals necessary to complete the Work as specified.

Measurement: Payment shall be made by linear feet of installed Type F-5M or F-5W farm fence.

Payment: Payment shall be made by linear feet of fence installed and approved by the Owner's Representative. Fence shall be paid in accordance with the unit cost contained in the contract documents.

(AB) **Combination Fence (Bid Item No. 25):**

General: This work item includes construction of all Type F-2M or F-2W combination woven wire and barbed wire fence and gates. This fence will be installed around the sediment basins north of Old Highway 10.

Work Included:

- Fence for the sediment basins
- Installation of gates
- Provide all labor, tools, equipment, materials, and incidentals necessary to complete the Work as specified.

Measurement: Payment shall be made by linear feet of installed Type F-2M or F-2W combination woven wire and barbed wire fence.

Payment: Payment shall be made by linear feet of fence installed and approved by the Owner's Representative. Fence shall be paid in accordance with the unit cost contained in the contract documents.

(AC) **Pole Fence (Bid Item No. 26):**

General: This work item includes construction of new pole fence to replace the existing corral fence at Ranchland Packing.

Work Included:

- Pole fence for the Ranchland Packing corrals
- Provide all labor, tools, equipment, materials, and incidentals necessary to complete the Work as specified.

Measurement: Payment shall be made by linear feet of installed pole fence.

Payment: Payment shall be made by linear feet of fence installed and approved by the Owner's Representative. Fence shall be paid in accordance with the unit cost contained in the contract documents.

(AD) **Site Security (Bid Item No. 27):**

General: Site security shall include payment for two security guards during working hours and one security guard during non-working hours, plus required equipment and materials.
Work Included:

- Provide two security guards during working hours
- Provide one security guard during non-working hours
- Provide all labor, tools, equipment, materials, and incidentals necessary to complete the Work as specified.

Measurement: This item shall be measured by the man-hour. The Contractor shall provide payroll records of hours worked to the Owner's Representative for review.

Payment: Payment shall be by the man-hour. Payment for site security shall be made according to the unit price contained in the contract documents.

(AE) **Provide Water (Bid Item No. 28):**

General: This work item includes providing water for all construction activities, especially for dust control and compaction moisture requirements.

Work Included:

- Provide all labor, tools, equipment, materials, and incidentals necessary to maintain consistent and reliable application of water to appropriate work areas.

Measurement: This item shall be measured by the thousand gallons of water applied to the work areas. This may be accomplished by counting tank truck loads with pre-measured tank volumes. The Contractor shall maintain records of water use and transmit these to the Owner's Representative.

Payment: Payment shall be made by the thousand gallons of water applied. Providing water shall be paid in accordance with the unit cost contained in the contract documents.

(AF) **Recontouring Floodplain to Accommodate Greenway Trail Construction (Bid Item No. 29):**

General: This work item includes construction of the Greenway Trail subgrade as shown on the Drawings.

Work Included:

- Grade and compact sub-base materials.
- Provide, place, compact and grade crushed aggregate surface course.
- Provide materials testing.
- Provide all labor, tools, equipment, materials, and incidentals necessary to complete the work as specified.

Measurement: This item shall be measured by the linear foot of trail subgrade constructed measured along the centerline of the trail alignment. Diversion and stream crossings are not included in the trail length.

Payment: Payment shall be made by the linear foot. Greenway Trail subgrade construction shall be paid in accordance with the unit cost contained in the contract documents.

(AG) **Drainage Swale (Bid Item No. 30):**

General: This work item includes construction of a drainage swale along a portion of the Greenway Trail subgrade as shown on the Drawings.

Work Included:

- Grade swale to dimensions shown on the drawings.
- Provide all labor, tools, equipment, materials, and incidentals necessary to complete the work as specified.

Measurement: This item shall be measured by the linear foot drainage swale constructed along the Greenway Trail subgrade.

Payment: Payment shall be made by the linear foot. Drainage swale construction shall be paid in accordance with the unit cost contained in the contract documents.

APPENDIX A-2

Technical Specifications

Subarea 1, Reach A, Streamside Tailings Operable Unit
Silver Bow Creek/Butte Area NPL Site

TECHNICAL SPECIFICATIONS

100 General Provisions
101.00 ABBREVIATIONS
140.00 CONTRACTOR QUALITY CONTROL

200 Earthwork
201.00 CLEARING AND GRUBBING
202.00 EXCAVATION AND EMBANKMENT
205.00 RECONSTRUCTED CHANNEL

300 Soil Preparation, Amendments, and Seeding
315.00 ORGANIC SOIL AMENDMENT
328.00 STREAMBANK SEEDING
330.00 MULCH
340.00 EROSION CONTROL MAT
345.00 COIR FABRIC MATERIALS

500 Miscellaneous Sitework
510.00 OWNER'S REPRESENTATIVE'S FIELD OFFICE
511.00 ABANDON EXISTING MONITORING WELLS
520.00 FARM FENCE
525.00 GABIONS
535.00 STONE
536.00 ROCK COVER
545.00 INCIDENTAL DEWATERING AND COFFERDAMS
548.00 DIVERSION SYSTEM
550.00 TRAFFIC CONTROL
555.00 COUNTY ROAD CULVERT CROSSING

600 Piped Utilities and Drainage Systems
610.00 STORM DRAIN AND CULVERTS
650.00 CONSTRUCTION FABRIC

700 Structures
710.00 STRUCTURAL CONCRETE

800 Surfacing - Aggregate, Base Courses, and Pavement
810.00 AGGREGATE BASE COURSE
820.00 CRUSHED TOP SURFACING COURSE

SECTION 100: GENERAL PROVISIONS

SECTION 101.00: ABBREVIATIONS

Whenever in these Specifications or in other Contract Documents, the following terms, or pronouns in place of them, are used, the intent and meaning shall be interpreted as follows. Reference to a specific standard or specification shall mean the latest edition or amendment in effect on the date of Invitation to Bid.

AA--Aluminum Association
AAN--American Association of Nurserymen
AASHTO--American Association of State Highway and Transportation Officials
ACI--American Concrete Institute
AGC--Associated General Contractors of America
AI--Asphalt Institute
AIA--American Institute of Architects
AISC--American Institute of Steel Construction
AISI--American Iron and Steel Institute
AITC--American Institute of Timber Construction
ANSI--American National Standards Institute
APA--American Plywood Association
API--America Petroleum Institute
ASA--American Society of Agronomy, Inc.
ASCE--American Society of Civil Engineers
ASHRAE--American Society of Heating, Refrigerating and Air Conditioning Engineers
ASLA--American Society of Landscape Architects
ASME--American Society of Mechanical Engineers
ASPA--American Sod Producers Association
ASTM--American Society for Testing and Material
AWPA--American Wood Preservers Association
AWS--American Welding Society
CLFMI--Chain Link Fence Manufacturers Institute
CRSI--Concrete Reinforcing Steel Institute
CS--Commercial Standard issued by U.S. Department of Commerce
DEMA--Diesel Engine Manufacturers Association
EJMA--Expansion Joint Manufacturers Association
EPA--Environmental Protection Agency
FED. SPEC. or FS--Federal Specifications
FHWA--Federal Highway Administration
FPR--Federal Procurement Regulations System
FSS--Federal Specifications and Standards
GSA--General Services Administration
IEEE--Institute of Electrical and Electronic Engineers
IES--Illuminating Engineering Society
IMSA--International Municipal Signal Association
ITE--Institute of Traffic Engineers
MCA--Montana Code Annotated
MDOH--Montana Department of Highways
MIL--Military Specifications
MSHA--Mine Safety and Health Administration
MUTCD--Manual on Uniform Traffic Control Devices
NBFU--National Board of Fire Underwriters
NBS--National Bureau of Standards

NEC--National Electric Code
NEMA--National Electrical Manufacturers Association
NESC--National Electrical Safety Code
NFPA--(Fire)--National Fire Protection Association
NFPA--(Forest)--National Forest Products Association
NSWMA--National Solid Wastes Management Association
NWMA--National Woodwork Manufacturers Association
OSHA--Occupational Safety and Health Act
PCA--Portland Cement Association
PCI--Prestressed Concrete Institute
PS--Product Standard issued by the U.S. Department of Commerce
RIS--Redwood Inspection Service
SAE--Society of Automotive Engineers
SDI--(Deck)--Steel Deck Institute
SDI--(Door)--Steel Door Institute
SJI--Steel Joist Institute
SMACNA--Sheet Metal and Air Conditioning Contractors' National Association
SSPC--Steel Structures Painting Council
SSSA--Soil Science Society of America, Inc.
TAS--Technical Aid Series
UL--Underwriter's Laboratories, Inc.
USASI--United States of America Standards Institute
USDA--United States Department of Agriculture
WASHTO--Western Association of State Highway Transportation Officials
WCLIB--West Coast Lumber Inspection Bureau
WWPA--Western Wood Products Association

SUBSECTION 140.00: CONTRACTOR QUALITY CONTROL

140.01 GENERAL

A. QUALITY CONTROL PLAN

Furnish for approval by the Owner, the Contractor Quality Control (CQC) Plan within 10 calendar days of Notice to Proceed. The plan shall identify personnel, procedures, instructions, records and forms to be used. Failure to submit an acceptable QC plan within the time herein prescribed, the Owner may refuse to allow construction to start until such time as an acceptable final plan is submitted.

The Contractor Quality Control Plan shall include, as a minimum, the following:

1. A description of the quality control organization, including a chart showing lines of authority and acknowledgment that the Contractor's QC staff shall report to the Project Manager or someone higher in the Contractor's organization.

2. The name, qualifications, duties, responsibilities, and authorities of each person assigned a QC function.

3. A copy of a statement signed by an authorized official of the Contractor's firm, which describes the responsibilities and delegates the authorities of the CQC Manager.

4. Procedures for scheduling and managing submittals, including those of subcontractors, offsite fabricators, suppliers, and purchasing agents.

5. Control testing procedures for each specific test. (Testing laboratories must be approved by the Owner.)

6. Reporting procedures including proposed reporting formats.

Acceptance of the plan by the Owner is required prior to the start of construction. Acceptance is conditional and will be predicated on satisfactory performance during the construction.

After acceptance of the CQC plan by the Owner, the Contractor shall notify the Owner in writing of any proposed changes. Proposed changes are subject to acceptance by the Owner.

B. QUALITY CONTROL ORGANIZATION

CQC Manager shall be responsible for overall management of the CQC and have the authority to act in all CQC matters for the Contractor. The CQC Manager for this contract shall be an approved, qualified hazardous material removal Owner or comparable individual to ensure compliance with contract plans and specifications. This person shall demonstrate his/her ability to perform correctly the duties required of him/her to the satisfaction of the Owner and shall be physically at the project site whenever work is in progress and will be in charge of the Contractor's Quality Control program for this project. All the Contractor's submittals for approval shall be reviewed and modified or corrected as needed by him/her or his/her authorized assistants and approved correct prior to forwarding of such submittals to the Owner.

The personnel of the CQC staff shall be fully qualified by experience and technical training to perform their assigned responsibilities and shall be directly hired by and work for the Contractor.

C. SUBMITTALS

Submittals shall be as specified in the Special Provisions. The CQC Organization shall be responsible for certifying that all submittals are in compliance with the contract requirements.

140.02 MATERIALS (NOT USED)

140.03 EXECUTION

A. CONTROL

1. Contractor Quality Control is the means by which the Contractor assures himself that his/her construction complies with the requirements of the contract plans and specifications. The controls shall be adequate to cover all construction operations, including both onsite and offsite operations, and will be keyed to the proposed construction sequence. The controls shall include at least three phases of inspection for all definitive features of work as follows:

   a. Preparatory Inspection: This shall be performed prior to beginning any definable feature of work. It shall include a review of contract requirements; a check to assure that all materials and/or equipment have been tested, submitted and approved; a check to assure that provisions have been made to provide required control testing; examination of the work area to ascertain that all preliminary work has been completed and a physical examination of materials, equipment, and sample work to assure that they conform to approved shop drawings or submittal data and that all materials and/or equipment are on hand.

   b. Initial Inspection: This shall be performed as soon as a representative portion of the particular feature of work has been accomplished and shall include examination of the quality of workmanship and a review of control testing for compliance with contract requirements, use of defective or damaged materials, omissions, and dimensional requirements.

   c. Follow-Up Inspection: These shall be performed daily to assure continuing compliance with contract requirements, including control testing, until completion of the particular feature of work. Such inspection shall be made a matter of record in the CQC documentation as required below. Final follow-up inspections shall be conducted and deficiencies corrected prior to the addition of new features of work.

B. TESTS

1. Test Procedures: Perform tests specified or required to verify that control measures are adequate to provide a product which conforms to contract requirements. Procure the services of an industry recognized testing laboratory or he/she may establish an approved testing laboratory at the project site. A list of tests which the Contractor understands he/she is to perform shall be furnished as part of the CQC plan to the Owner. The list shall give the test name, specification paragraph containing the test requirements and the personnel and laboratory responsible for

following data:

a. Verify that testing procedures comply with contract requirements.

b. Verify that facilities and testing equipment are available and comply with testing standards.

c. Verify that test instrument calibration data are checked against certified standards.

d. Verify that recording forms, including all of the test documentation requirements, have been prepared.

C. COMPLETION INSPECTION

At the completion of all work, or any increment thereof, established by a completion time stated in the paragraph entitled "Commencement, Prosecution and Completion of Work" or stated elsewhere in the specifications, the CQC Manager shall conduct a completion inspection of the work and develop a "punch list' of items which do not conform to the approved plans and specifications. Such a list shall be included in the CQC documentation, as required below, and shall include the estimated date by which the deficiencies will be corrected. The CQC Manager or his/her staff shall make a second completion inspection to ascertain that all deficiencies have been corrected and so notify the Owner. The completion inspection and any deficiency corrections required by this paragraph will be accomplished within the time stated for completion of the entire work or any particular increment thereof if the project is divided into increments by separate completion dates.

D. DOCUMENTATION

1. Maintain current records of quality control operations, activities, and tests performed including the work of suppliers and subcontractors. These records shall be on an acceptable form (sample form attached) and indicate a description of trades working on the project, the numbers of personnel working, the weather conditions encountered, any delays encountered, and acknowledgment of deficiencies noted along with the corrective actions taken on current and previous deficiencies. In addition, these records shall include factual evidence that required activities or tests have been performed, including but not limited to the following:

   a. Type and number of control activities and tests involved.

   b. Results of control activities or tests.

   c. Nature of defects, causes for rejection, etc.

   d. Proposed remedial action.

   e. Corrective actions taken.

2. These records shall cover both conforming and defective or deficient features and shall include a statement that supplies and materials incorporated in the work comply with the requirements of the contract. Legible copies of these records shall be furnished to the Owner's Representative daily.

E. NOTIFICATION OF NONCOMPLIANCE

The Owner's Representative will notify the Contractor of any noncompliance with the foregoing requirements. After receipt of such notice, the Contractor shall take immediate corrective action. Such notice, when delivered to the Contractor or his/her representative at the site of the work, shall be deemed sufficient for the purpose of notification. If the Contractor fails or refuses to comply promptly, the Owner may issue an order stopping all or part of the work until satisfactory corrective action has been taken. No part of the time lost due to any such stop orders shall be made the subject of claim for extension of time or for excess costs or damages by the Contractor.

(The attached QC Daily Report is part of this Section)

QUALITY CONTROL DAILY REPORT

(CONTRACTOR)

REPORT NO._____ CONTRACT NO._____ DATE_____

LOCATION OF WORK:_____

DESCRIPTION:_____

WEATHER_____,RAINFALL_____INCHES, TEMP: MIN_____MAX_____

1. Work performed today by Contractor (include Plant and Labor breakdown):_____

_____

2. Work performed today by Subcontractors (include Plant and Labor breakdown):_____

_____

3. List specific inspection performed and results of these inspections (include Corrective Actions):

_____

4. List type and location of tests performed and results of these tests:_____

_____

5. Verbal Instructions received from Owner on construction deficiencies or re-testing required:____

_____

_____

6. Remarks:_____

7. CERTIFICATION: I certify that the above report is complete and correct and that I, or my authorized representative, have inspected the work performed this day by the Contractor and each subcontractor and have determined that all materials, equipment and workmanship are in strict compliance with the plans and specifications except as may be noted above.

_____

Contractor's Designated Quality Control Manager

SECTION 200: EARTHWORK

SUBSECTION 201.00: CLEARING AND GRUBBING

201.01 GENERAL

A. DESCRIPTION - This work shall consist of clearing, grubbing, removing, burning, burying, and otherwise disposing of vegetation and debris within the clearing limits as designated on the Drawings and by the Engineer. Vegetation and objects designated to remain shall be preserved free from injury and defacement.

If any evidence of aboriginal activity or occupation is encountered, the Contractor shall immediately stop work and notify the Engineer, who shall contact the proper state authorities for an assessment of the significance of the resource.

The work shall be classified as follows:

1. Clearing. Clearing shall consist of the felling of trees and disposal of stumps, brush, windfalls, logs, limbs, sticks, piles of sawdust, rubbish, debris, vegetation, and other objectionable matter existing within the clearing limits or that interfere with excavation and embankment.

2. Grubbing. Grubbing shall consist of the removal and disposal of roots, stumps, stubs, rock, roots, debris, and other objectionable matter from the grubbing limits.

3. Clearing and Grubbing. Clearing and grubbing shall consist of performing both clearing and grubbing as set forth above.

4. Disposal. Disposal shall consist of removing, burning, burying, or otherwise disposing of the refuse accumulations from clearing, grubbing, or clearing and grubbing operations. The refuse resulting from these operations shall be disposed of in the same manner as debris described in Subsection 502.00, Debris and Structure Removal.

201.02 MATERIALS

Not applicable.

201.03 CONSTRUCTION REQUIREMENTS

A. GENERAL - Clearing, grubbing, or clearing and grubbing shall be done at times and in a manner that the surrounding vegetation, adjacent property, and anything designated to remain shall not be damaged. Dragging, piling, disposing of debris, and other work that may be injurious to vegetation shall be confined to areas that carry no vegetation or that will be covered by embankments or disturbed by excavations.

Vegetation adjacent to streams, ponds, or lakes shall be preserved and protected from injury unless the vegetation conflicts with construction operations and is designated by the Engineer to be removed. If any vegetation designated to be preserved becomes damaged or destroyed by the Contractor, it shall be replaced to the satisfaction of the Engineer at no cost to the Owner.

The Engineer will designate trees, shrubs, plants, or other objects that are to remain. The Contractor shall preserve all objects so designated.

The Contractor shall not injure trees, shrubbery, vines, plants, grasses, and other vegetation growing outside of the slope limits of excavation and embankment. The Contractor shall paint all cut or scarred surfaces of trees or shrubs selected for retention. The paint shall be an approved asphaltum base paint prepared especially for tree surgery.

Where scour is likely to occur, resulting from clearing or grubbing conducted in advance of excavation work, temporary erosion control setting basins shall be constructed prior to any scour occurring.

B. CLEARING - All areas within the neat lines of cut or fill areas shall constitute the clearing limits.

Unless specifically designated to be saved, all trees, stumps, brush, windfalls, logs, and other objectionable matter occurring within clearing limits shall be cut off and disposed of. All stumps within the clearing limits and all trees, the stumps of which are not to be grubbed, shall be cut not more than the diameter of the stump, and in any instance not more than 12 inches, above the ground.

The refuse resulting from the clearing operation shall be removed, as specified in Subsection 502.00, Debris and Structure Removal, to a location designated by the Engineer, or, if no site is specified, then the Contractor shall secure a waste site. The Contractor shall not burn on the site unless he has obtained permission as specified in Subsection 502.00, Debris and Structure Removal. In all cases, the authority to burn shall not relieve the Contractor in any way from damages which may result from his operations. In no case shall any material be left on the project, shoved onto abutting private properties, or be buried in embankments or trenches on the project.

C. GRUBBING - All areas within the neat lines of cuts, and all areas to be covered by embankments less than 3 feet in height shall constitute the grubbing limits.

All stumps, roots, logs, or other timber more than 3 inches in diameter, and all brush, matted roots, rock, and other debris within the grubbing limits not suitable for roadway foundation shall be pulled or otherwise removed to a depth of not less than 6 inches below the original ground or 12 inches below roadway subgrade.

All material resulting from the grubbing operations shall be disposed of as specified in Subsection 502.00, Debris and Structure Removal. All depressions below subgrade, or below the final surface of the ground resulting from the grubbing operations shall be backfilled with suitable material as specified in the Subsection 202.00, Excavation and Embankment.

D. CLEARING AND GRUBBING - Clearing and grubbing shall be done in accordance with the provisions of B and C above.

SUBSECTION 202.00: EXCAVATION AND EMBANKMENT

202.01 GENERAL

A. DESCRIPTION - All excavation, embankment, and grading work shall be in accordance with these Specifications and in reasonably close conformity with the lines, grades, and elevations shown on the Drawings or as established by the Engineer.

1. Excavation. This work shall consist of performing all operations necessary to excavate, grade, and satisfactorily dispose of all materials encountered during excavation at the areas designated on the Drawings. The work shall include roadway excavation, structure excavation, excavation of mine working, ditch or channel excavation, any general unclassified excavation, and all other excavation not covered under other subsections of these Standard Specifications.

2. Embankment. This work shall consist of performing all operations necessary to prepare, backfill, compact, and grade all areas requiring embankment or fill as shown on the Drawings. The work shall include roadway embankment, structure embankment, dike embankment, backfilling mine workings and depressions, cut and fill terracing, and all other backfilling or embankment not covered under other subsections of these Standard Specifications.

B. SUBMITTALS - The Contractor shall provide the following submittals in accordance with the Supplementary Conditions:

* Moisture-density characteristics using AASHTO T-99 for embankment or backfill material and excavated subgrades. As material types change during construction, additional moisture-density characteristics may be required by the Contractor or Engineer.

* Backfill imported from an off-site source shall be tested and submitted, including source location, gradation, and moisture-density characteristics.

C. REFERENCE STANDARDS - Maximum density shall be determined by AASHTO T-99 and is defined as the maximum dry weight in pounds per cubic foot obtained when a material is mixed with different percentages of water and compacted in a standard manner. The percentage of water at which maximum density is obtained is termed the optimum moisture content.

The percent compaction is defined as the density of the compacted layer expressed as a percentage of the maximum density of the material when tested in accordance with these Specifications.

The percentage of compaction is computed by the formula:

$$\text{Percent compaction} = \frac{\text{Field Density}}{\text{Maximum Density}} \times 100$$

202.02 MATERIALS

A. ON-SITE MATERIALS - Suitable materials for embankments and backfill shall be taken from designated excavation areas. Stumps, trees, rubbish, vegetation, frozen lumps, or other unsuitable materials shall not be placed in embankments. Large rock will only be considered suitable if it does not adversely affect the requirements for compaction.

B. ROADWAY MATERIALS - Requirements for roadway materials are specified under Section 800, Surfacing - Aggregate, Base Courses, and Pavement of the Standard Specifications.

C. IMPORTED MATERIALS - Imported backfill materials shall meet the requirements specified in Section 202.02-A above and shall be approved by the Engineer prior to delivery of the material to the project. All areas used as a material source or for stockpiling shall be reclaimed by the Contractor at his cost unless such areas are designated as Approved Areas of Disturbance as defined in the Supplementary Conditions.

202.03 CONSTRUCTION REQUIREMENTS

A. GENERAL - All excavation and embankment shall be considered unclassified and shall consist of the removal or disposal of any and all material encountered regardless of type or nature obtained within the construction limits designated on the Drawings.

All suitable materials removed from excavation shall be used insofar as possible for backfill and in embankments.

B. SITE PREPARATION - All areas scheduled for excavation and embankment shall be cleared and grubbed in accordance with Subsection 201.00, Clearing and Grubbing.

Prior to excavation and embankment work, all suitable topsoil and subsoil in the scheduled work areas shall be salvaged in accordance with Subsection 310.00, Cover Soil.

C. LINE AND GRADE CONTROL - Prior to excavation, backfill, grading, and embankment operations, the Contractor shall perform all necessary surveys for control of line and grade and establish stable and protected monuments for reference throughout the construction period. A sufficient number of such monuments shall be provided throughout the work to permit verification of the work within the tolerances specified.

D. EXCAVATION

1. General. The Contractor shall utilize excavating equipment appropriate for the work being performed. The method of excavation shall be the Contractor's responsibility. All methods and equipment used shall result in finished work meeting the construction tolerances specified. No work shall be performed beyond the construction limits without prior written approval from the adjoining landowners and the Engineer.

2. Dewatering. Ground water encountered during excavation shall be removed to avoid interfering with any construction activity. The cost of dewatering operations shall be merged with and considered part of the excavation cost.

3. Shoring, Sheeting, and Bracing. The Contractor shall do all shoring, bracing, and tight sheeting required to prevent caving and to protect his workmen, in accordance with the Occupational Safety and Health Regulation Requirements, and to protect adjacent

property and structures. No separate payment shall be made for these items and the cost thereof shall be considered part of the excavation cost unless otherwise shown or specified for the project.

4. Surplus and Waste Material. During excavation, where the ground foundation for embankments is composed of muck or other unstable materials, such materials shall be removed to the depth shown on the Drawings or as determined in the field by the Engineer and satisfactorily disposed. All holes created by removal of soft or unstable material shall be backfilled as specified for "Embankment". Backfill shall be obtained from the most select material encountered in excavation and shall be paid for only as is "Unclassified Excavation", unless otherwise approved in writing.

   All excavated material not used as mentioned above shall be used for embankment backfill or shall be wasted and disposed of by the Contractor at an approved disposal site. Finding disposal areas, placing waste material in these areas, and final leveling and cleanup of these disposal areas to the satisfaction of the property owner involved shall be entirely the Contractor's responsibility.

   When unsuitable material or debris is encountered during excavation, it shall be overexcavated until removed or until 1 foot below the established grade. Suitable material shall then be placed and compacted to bring the area to grade.

5. Maintenance of Subgrade and Drainage. During excavation, the subgrade shall be maintained in such a condition that it will be well drained at all times. Side ditches emptying from cuts to embankments shall be constructed to avoid damage by erosion.

   If it is necessary in the prosecution of the work to interrupt existing surface drainage, temporary drainage facilities shall be provided and maintained at the Contractor's expense until permanent drainage facilities are completed. The Contractor shall be responsible for, and shall take all necessary precautions to protect and preserve any and all existing subsurface drains, conduits, utilities, and other underground structures or parts thereof which may be affected by the construction, and which in the opinion of the Engineer may be properly continued in use without any change. The Contractor shall, at his own expense, repair all damage to facilities or structures which results from any of his operations or his negligence.

   Erosion checks shall be constructed perpendicular to ditches and as detailed on the Drawings.

E. STRUCTURE EXCAVATION

1. All Structures. Excavation adjacent to existing structures shall not commence until authorized by the Engineer.

   Excavations for structures or structure footings shall be to the lines and grades or elevations shown on the Drawings. They shall be of sufficient size to permit the construction of structures or structure footings. The elevations of the bottoms of footings, as shown on the Drawings, shall be considered as approximate.

   Boulders, wood, and any other unsuitable materials encountered in the excavation shall be removed and disposed of at an approved disposal site.

The Contractor shall notify the Engineer when each excavation is complete. Footings shall not be placed without first notifying the Engineer.

Excavations over 5 feet deep, except in solid rock, shall have side slopes of 1 to 1 or flatter, depending upon conditions at the individual site and in accordance with OSHA regulations. When the laying back of excavation slopes is precluded, supporting systems shall be used to retain the sides of excavations greater than 5 feet deep. Sides of excavations less than 5 feet deep shall also be effectively protected when hazardous ground movement may be expected.

Where concrete is to be placed on any excavated surface, special care shall be taken not to disturb the bottom of the excavation more than necessary. When the excavation is at the required depth, all water shall be pumped out for cleaning the foundation bed for inspection. All loose and disintegrated rock and thin strata shall be removed. All seams or crevices in rock strata shall be cleaned out and filled with concrete mortar. When the foundation material is soft or otherwise unsuitable, the unsuitable material shall be removed and the area shall be backfilled with approved compacted, granular material.

When foundation piles are used, the excavation of each pit shall be completed before the piles are driven. Foundation backfill shall be placed after the piles are driven. After the driving is completed, all loose and displaced material shall be removed, leaving a smooth, solid bed to receive the footing.

2. Cofferdams. Watertight cofferdams or cribs shall be used wherever waterbearing strata are encountered above the elevation of the bottom of the excavation. For this purpose, a cofferdam or crib is defined as an enclosed single- or double-wall braced structure with walls sheeted with timber, concrete or steel, and which shall extend well below the bottom of the excavation when practical. Earthen or rockfill dikes, dams, or embankments are not considered cribs or cofferdams for this purpose.

The design and construction of supporting systems, if used, shall be the responsibility of the Contractor in accordance with the following provisions. The Contractor shall submit 5 sets of drawings showing the proposed method of cofferdam or crib construction and 5 copies of the design calculations, fully annotated and referenced. The design calculations and drawings submitted shall bear the signature and seal of a State of Montana registered Professional Engineer.

Supporting systems shall be designed to withstand the expected loads and pressures, including surcharge, water and earth, which may occur during the period for which they are used. Surcharge, earth, and water pressure diagrams, and the method of supporting system analysis and design, shall meet accepted engineering practice. For new materials, the allowable working stresses of the materials shall be as recommended by the manufacturer for the construction conditions encountered. For used materials or when manufacturer's recommendations are not available or applicable, the allowable working stresses shall be as specified in AASHTO's "Standard Specifications for Highway Bridges".

In general, the interior dimensions of cofferdams shall be sufficient to give clearance for the construction of forms and the inspection of their exteriors, and to permit pumping outside of the forms. Cofferdams or cribs that are tilted or moved internally during the process of sinking shall be righted or enlarged to provide the necessary clearance.

When conditions make it impracticable to dewater the foundation before placing a footing, a concrete foundation seal with dimensions as necessary to resist uplift pressures shall be constructed. The concrete for the seal shall be placed as shown on the Drawings. The foundation shall then be dewatered and the footing placed. When weighted cribs are employed and the weight is utilized to partially overcome the hydrostatic pressure acting against the bottom of the foundation seal, special anchorage such as dowels or keys shall be provided to transfer the entire weight of the crib to the foundation seal. When a foundation seal is placed under water, the cofferdam shall be vented or ported at low water level.

Cofferdams shall be constructed to protect green concrete against damage from sudden rising of water levels and to prevent damage to the foundation by erosion. Timber or bracing that extends into substructure masonry shall not be left in cofferdams or cribs.

Pumping from the interior of any foundation enclosure shall be done in a manner that will not carry concrete materials away.

All pumping required during the placing of concrete, or for a period of at least 24 hours thereafter, shall utilize a suitable sump located outside the concrete forms. Pumping to dewater a sealed cofferdam shall not start until the seal has set sufficiently to withstand the hydrostatic pressure.

Cofferdams or cribs, and all sheeting and bracing shall be removed after completion of the substructure. Removal shall not disturb or mar finished masonry.

F. EMBANKMENT

1. Foundation Preparation. Site preparation including topsoil salvage work shall conform to the requirements as specified herein.

After topsoil stripping, all areas which will be receiving fill shall be scarified to a depth of 6 inches, watered, and compacted in conjunction with the first lift of new fill. When embankments are to be placed on a hillside, or where new fill is to be placed against existing embankment, the slope of the original hillside, or old fill respectively, shall be benched or stepped by cutting into it horizontally, for a minimum distance of 12 inches. These measures will provide a secure bond between the new and existing materials. Each bench shall be cut as close to the one below as the slope of the ground will permit. Materials thus cut out of the benches shall be incorporated into the new fill. Costs for constructing the benches shall be included in the price for the work performed herein, and no additional compensation will be allowed.

2. Placement. Embankment and backfill materials shall not be placed until the required excavation and foundation preparation have been completed and the foundation has been inspected and approved by the Engineer. Fill materials shall not be placed upon frozen surfaces, nor shall it contain snow, ice or frozen materials.

Embankment shall be constructed of materials excavated on-site or borrowed materials from approved sources. Embankment shall be placed to the lines and grades indicated in uniform layers as required to obtain the specified compaction throughout the embankment. Each layer of embankment shall be completed, leveled, compacted, and tested, if required, before the succeeding layer is placed. The embankment surface is to be kept level and uniform at all times.

Embankment material shall not be excessively dry or wet when placed. If necessary, the Contractor shall manipulate the material as required to assure that compaction will be performed at or near the optimum moisture content given in the moisture-density curve. Jetting or ponding of the backfill materials will not be allowed.

The site shall be adequately dewatered prior to placing any embankment or attempting compaction such that ground water is not intruding into the material.

If it should become necessary because of weather or other conditions to suspend grading operations, the entire area worked upon shall be bladed until smooth, free of depressions and ruts, and crowned so no water can collect or be impounded.

Areas inaccessible to rollers shall be compacted by hand or mechanical tampers or other means until the density conforms to adjacent embankment, compacted in accordance with these Specifications.

Whenever the surface of a proposed cut or the site of an embankment is frozen or is covered with snow or ice sufficient to impair the stability of the work, the frozen earth material and snow and ice must be removed at no cost to the Owner. Work of this nature shall be completed at least 300 feet in advance of the excavation and placing of the embankment material. Frozen excavation or that lying under a blanket of snow of such extent as to preclude its placement in the embankment will be considered cause for suspending grading operations.

Embankment constructed during the winter shall be refinished to grade, cross-section, and compaction requirements after the frost is out of the ground and the embankment is in suitable condition for work.

3. Structure Embankment. Adjacent to structures, backfill materials shall be placed in a manner which will prevent damage to the structures and allow the structures to assume the loads from fill gradually and uniformly. The height of the fill adjacent to a structure shall be increased at approximately the same rate on all sides of the structure. The maximum size of rock fragments in backfill adjacent to the structure shall be 2 inches.

   Backfill materials shall not be placed and compacted against any structure for a minimum period of 14 days after the placement of concrete, or until 90% of design strength has been attained through testing.

G. REMOVAL AND PLACEMENT OF DEFECTIVE FILL - Embankment and backfill materials not conforming to the density and moisture requirements shall be reworked until the requirements are achieved or removed and replaced by acceptable fill. The replacement fill, foundations, abutment and fill surfaces upon which it is placed shall conform to all requirements of specifications for Foundation Preparation, Placement, Moisture and Density Requirements contained herein.

H. MOISTURE AND DENSITY REQUIREMENTS - Each layer of embankment and backfill material shall be compacted until the in-place density exceeds 90% of its maximum dry density. In no case will compaction be less than that of adjacent undisturbed material. For roadway and structure embankments, compaction shall be 95% of maximum. For excavation cuts, compaction shall be equal to or greater than that of the adjacent undisturbed material. Cost of compaction, rolling, and watering is incidental to the earthwork bid item listed on the Proposal.

Water required shall be sufficient to obtain optimum moisture content plus or minus a minimum 3% as determined by AASHTO T-99, ASTM D 698, Standard Proctor Method A, B, C, or D, as applicable. The Engineer may periodically measure the degree of compaction (field density) during embankment construction. Measurements will be based on optimum moisture and maximum density curves submitted.

Field or in-place density refers to the dry density expressed in pounds per cubic foot of a layer of compacted material in place at the site as determined by a sample representative of the compacted layer. The field density shall be determined in accordance with AASHTO T-147, AASHTO T-181, ASTM D 1556,or ASTM D 2167.

I. HAUL - When constructing embankments or wasting, the cost of hauling shall be included in the Contract unit price bid for earthwork item on the Proposal.

J. FINE GRADING - After the earthwork has been substantially completed and after all underground utilities, drainage facilities, etc. have been installed or adjusted to grade, the embankment shall be brought to the lines, grades, and cross-sections shown on the Drawings, and compacted to the required density.

The Contractor shall increase heights above grade and increase widths as necessary to allow for settlement, consolidation, or compaction. Otherwise construction tolerances for earthwork shall be ± 0.2 feet of line and grade.

Side slopes shall be finished to a reasonable uniform but rough surface that blends to the contours of surrounding undisturbed ground. Smooth surfaces shall be scarified perpendicular to the slope of the ground.

K. TOPSOILING AND CLEANUP - After fine grading work is accepted, salvaged topsoil shall be replaced to cover those areas to be seeded as designated on the Drawings and according to Subsection 310.00, Cover Soil.

The Contractor shall remove all tools, equipment, excess materials, debris, etc. from the vicinity of the work.

SUBSECTION 205.00: RECONSTRUCTED CHANNEL

205.01 GENERAL

A. DESCRIPTION

Work included in this Subsection shall consist of supplying all necessary equipment, materials, and labor required to build a reconstructed channel within Reach A, Subarea 1, Silver Bow Creek SSTOU. Work items shall consist of reconstructed channel excavation, placement of new streambed material, and channel bank construction which includes placement of stone streambank materials, streambank subsoil and cover soil, streambank seeding, and installation of coir fabric. Flows in Silver Bow Creek will be diverted from the existing channel into a diversion channel as detailed in Subsection 548 - Diversion System, of these Specifications and as shown on the Drawings. A crossing of an existing county road will also be required.

NOTE: No construction of the reconstructed channel shall occur between Stations 12+00 and 13+00 on the Left Bank, and between Stations 12+00 and 13+85 on the Right Bank under this contract.

Construction shall also be excluded at three locations within the uppermost 940 feet of channel, beneath the Interstate highway bridges and Silver Bow County water lines. These exclusion areas include the following: 1) Station 0+00 to 2+10, 2) Station 4+05 to Station 4+45, and 3) Station 8+30 to 9+40. The total length of excluded channel construction between Station 0+00 and 9+40 is 360 feet.

B. RELATED WORK

Work in this Subsection shall be coordinated with work in the following, related Subsections:

Subsection 202 - Excavation and Embankment
Subsection 328 - Streambank Seeding
Subsection 525 - Gabions
Subsection 545 - Incidental Dewatering and Cofferdams
Subsection 548 - Diversion System
Subsection 555 - County Road Culvert Crossing

C. SUBMITTALS

Submit the names of all material suppliers in addition to all data sheets and test results for confirmation of compliance testing to the Owner's Representative prior to delivery of aggregate and geotextile materials to the site. All aggregate materials must be approved by the Owner's Representative prior to delivery to the site.

Quality assurance testing will be performed by the Contractor to insure compliance with the Specifications and Drawings. Testing will be performed in accordance with applicable ASTM (American Society for Testing and Materials) test methods unless otherwise specified. If tests indicate materials do not meet specified requirements, the Contractor shall remove all soils or materials not meeting the specified requirements and replace the failing soils or materials with those meeting the Specifications. Removal and replacement of rejected soils shall be at the Contractor's expense. The frequency and need for testing shall be determined by the Owner's Representative.

Applicable ASTM or AASHTO test methodologies, procedures, and standards shall govern for all soil sampling, soil sample preparation, soil classification, field compaction and moisture content testing of soils, and laboratory density and moisture content testing of soils.

Submit catalog data or brochures for manufactured items specified herein for use. Furnish certificates verifying that standards specified herein are met.

D. REGULATORY REQUIREMENTS

1. The Contractor shall comply with all Federal, State, and county water quality requirements and regulations.

2. The Contractor shall comply with all OSHA requirements and regulations including, but not necessarily limited to, electrical safety, trench safety, and excavation safety. All equipment and members of the Contractor's work force utilized on-site shall comply with all OSHA regulations.

205.02 MATERIALS

A. GENERAL

The materials used in the construction of the reconstructed channel shall conform to the requirements listed in the following Subsections.

Subsection 345 - Coir Fabric Materials
Subsection 535 - Stone
Subsection 610.02 - Storm Drain and Culverts (Materials)

B. DELIVERY/HANDLING/STORAGE

1. Stockpile materials at locations designated by the Owner's Representative. Stockpiles will not be allowed outside of project construction limits shown on the Drawings. Stockpile in sufficient quantities to meet project schedule and requirements. Stockpile differing materials with dividers or stockpile apart to prevent mixing. Direct surface water away from the stockpile to prevent erosion or product

deterioration. Leave stockpile area in a clean and neat condition and grade site to its previous elevation at the conclusion of use.

2. Each roll of coir/geotextile fabric shall be packaged individually in a suitable sheet, wrapper, or container to protect the fabric from damage to ultraviolet light, moisture, and mud during normal storage and handling.

3. Each roll shall be identified with a tag or label securely affixed to the outside of the roll on one end. The label shall include the manufacturer or supplier, the style number, and the roll and lot numbers.

4. Store all coir/geotextile fabric elevated off the ground and insure that they are adequately covered to protect the material from damage. Protect fabric from sharp objects which may damage the material.

5. Materials damaged during transport, storage or placement shall be replaced at the Contractor's expense.

6. The Owner's Representative may randomly select and obtain samples from rolls of coir/geotextile fabric after arrival on the site and prior to installation.

205.03 CONSTRUCTION REQUIREMENTS

A. PREPARATION

1. Construction Staking. Staking for the reconstructed channel shall be completed by the Owner's Representative prior to commencement of the work. Staking shall employ an offset layout for the channel such that stakes can remain undisturbed during construction. Survey monuments used for horizontal and vertical control on the project shall be clearly delineated in the field.

B. INSTALLATION (Stations 14+00 to 69+50)

The reconstructed channel for Reach A of Silver Bow Creek between these stations will be comprised of an entirely new alignment as shown on the Drawings. Construction activities shall include placement of streambed material and construction of channel banks including placement of streambank subsoil, cover soil, and coir fabric.

Excavation of the reconstructed channel and stockpiling of excavated materials shall be in accordance with Subsection 202 - Excavation and Embankments, of these Specifications. Excavated material shall be stockpiled adjacent to the channel, at locations approved by the Owner's Representative. Groundwater encountered during excavation shall be removed in accordance with Subsection 545 - Incidental Dewatering and Cofferdams, of these Specifications.

Streambed Material Placement. Streambed fill material shall be placed so as to secure a stone mass of the thickness, height, width and lines and grades shown on the Drawings, with a minimum of voids. The stone shall be manipulated sufficiently by means of suitable equipment to secure a reasonably regular surface and mass stability. Material requirements for the streambed fill can be found in Subsection 535 - Stone, of these Specifications.

A stone grade control structure shall be placed within the existing Silver Bow Creek channel immediately upstream of the diversion channel outfall. This grade control structure shall be constructed from an 18-inch layer of Type 1 stone as shown on the Drawings (Sheet I25). Stone shall be placed to its full course thickness at one operation and in such a manner as to avoid displacing the underlying material. Placing of stone protection in layers or by dumping into chutes or by similar methods likely to cause segregation will not be permitted.

Streambank Construction. Streambank construction includes placement of subsoil material, cover soil material, and coir fabric as shown on the Drawings. All streambanks shall be constructed to the lines and grades shown on the Drawings.

Subsoil material for streambank construction shall be obtained from Borrow Area 10 (BA 10), as designated on the Drawings. Subsoil shall be placed in the constructed streambanks to the lines and grades shown on the Drawings. Subsoil shall be compacted according to the requirements set forth in Section (D) below.

Cover soil, to be placed as the upper lift (4-inch minimum thickness) in the streambank construction profile, shall be obtained from Borrow Area 10 (BA 10); or the Contractor may elect to import cover soil material from an off-site source approved by the Owner's Representative. Cover soil, regardless of its source, must have an organic material content of 3%. Cover soils that do not meet the requirement of 3% organic material content must be amended by the Contractor. Specifications for an organic amendment are provided in Subsection 315 - Organic Soil Amendment, of these Specifications.

Cover soil shall be spread smoothly and evenly to a minimum depth of 4 inches and to the satisfaction of the Owner's Representative. All stones, root wads, and objectionable objects protruding from the surface of the cover soil shall be removed prior to seeding and/or fabric placement. The Contractor shall make every effort to keep cover soil out of the channel bed. Cover soil shall be compacted according to the requirements set forth in Section (D) below. Seed shall be broadcast over the cover soil, according to requirements set forth in Subsection 328 - Streambank Seeding, of these Specifications, prior to compacting the cover soil.

A woven coir fabric shall be placed as a covering over the face of the constructed streambanks, as shown on the Drawings. Fabric shall conform to the requirements shown in Subsection 345 - Coir Fabric Materials, of these Specifications. Areas to be covered by coir fabric shall be graded to a smooth condition free from protruding rocks, sticks, and other debris which may prevent a smooth application or damage the fabric. Care shall be taken to remove all objects that would interfere with application or damage the fabric materials.

Fabric protected slopes shall be shaped to the slope angles shown on the Drawings with smooth transitions between varying slopes. The Contractor shall handle the fabric and backfill in a manner which does not damage the fabric or deposit backfill material in the stream channel. Fabric shall be installed evenly, smoothly, and taut under the supervision of, and to the satisfaction of, the Owner's Representative.

The bank toe edge of the fabric shall be embedded into the streambed material and staked as shown on the Drawings. Adjacent pieces of fabric shall overlap a minimum of 36 inches in the direction of flow, with the upstream piece of fabric placed over the downstream piece of fabric.

A small trench shall be dug along the floodplain edge of the fabric, according to the Drawings, in order to key the fabric into the ground before staking. Fabric shall be staked in the key trench, as shown in the Drawings, with wooden stakes at a spacing of 3 feet apart. Material specifications for the stakes are presented in Subsection 345 - Coir Fabric Materials. Wooden stakes shall also be installed through the fabric on the exposed streambanks in a staggered pattern not more than 3 feet apart as needed to hold the fabric in place.

No foot traffic or equipment shall be allowed on the completed fabric protected slopes. Damaged erosion fabric shall either be replaced or patched as directed by the Owner's Representative. Patches shall overlap the affected area by a minimum of two feet. Repairs and fabric replacements shall be performed at no additional cost to the Owner.

C. INSTALLATION (Stations 0+00 to 12+00, with exclusion areas)

Channel construction upstream of the diversion structure in Reach A shall occur within the existing channel alignment of Silver Bow Creek. Construction activities shall include placement of streambed material and construction of channel banks including placement of stone material, filter gravel, streambank subsoil, cover soil, and coir fabric. Three areas shall be excluded from construction within this reach, as shown on Sheet I2 of the Drawings. The total channel length of the three excluded areas is 360 feet.

Excavation of the reconstructed channel and stockpiling of excavated materials shall be in accordance with Subsection 202 - Excavation and Embankments, of these Specifications. Excavated material shall be stockpiled adjacent to the channel, at locations approved by the Owner's Representative. Groundwater encountered during excavation shall be removed in accordance with Subsection 545 - Incidental Dewatering and Cofferdams, of these Specifications.

The upper portion of the existing banks within this reach is covered with remnant riprap material. The envelope of channel reconstruction is primarily located from the vegetated shelf at the present edge of channel to the channel bottom. At some locations it may be necessary to remove existing riprap material in order to construct the new channel banks. Removed riprap material shall be stockpiled adjacent to the channel, at locations approved by the Owner's Representative.

Streambed Material Placement. Streambed fill material shall be placed so as to secure a stone mass of the thickness, height, width and lines and grades shown on the Drawings, with a minimum of voids. The stone shall be manipulated sufficiently by means of suitable

equipment to secure a reasonably regular surface and mass stability. Material requirements for the streambed fill can be found in Subsection 535 - Stone, of these Specifications.

Streambank Construction. Streambank construction includes placement of Type 1 stone material, filter gravel, subsoil material, cover soil material, and coir fabric as shown on the Drawings. All streambanks shall be constructed to the lines and grades shown on the Drawings.

A 6-inch layer of filter gravel shall be placed over the channel construction corridor embankment prior to placement of Type 1 stone. The filter gravel shall be manipulated sufficiently by means of suitable equipment to secure a reasonably regular surface and mass stability. Filter gravel shall meet gradation requirements in Subsection 535 - Stone.

Type 1 stone material shall meet the gradation requirements in Subsection 535 - Stone, of these Specifications. Stone shall be placed to its full course thickness at one operation and in such a manner as to avoid displacing the underlying material. Placing of stone protection in layers or by dumping into chutes or by similar methods likely to cause segregation will not be permitted.

A fabric wrapped lift shall be constructed on top of the Type 1 stone and filter gravel materials as shown on the Drawings. The fabric wrapped lift shall consist of both subsoil and cover soil materials encapsulated in an inner layer of non-woven coir fabric and an outer layer of woven coir fabric. Subsoil and cover soil shall be compacted according to the requirements set forth in Section (D) below. The coir fabric shall meet the requirements found in Subsection 345 - Coir Fabric Materials, of these Specifications.

Subsoil material for streambank construction shall be obtained from Borrow Area 10 (BA 10), as designated on the Drawings. Subsoil shall be placed in the constructed streambanks to the lines and grades shown on the Drawings. Subsoil shall be compacted according to the requirements set forth in Section (D) below.

Cover soil, to be placed as the upper lift (4-inch minimum thickness) in the streambank construction profile, shall be obtained from Borrow Area 10 (BA 10); or the Contractor may elect to import cover soil material from an off-site source approved by the Owner's Representative. Cover soil, regardless of its source, must have an organic material content of 3%. Cover soils that do not meet the requirement of 3% organic material content must be amended by the Contractor. Specifications for an organic amendment are provided in Subsection 315 - Organic Soil Amendment, of these Specifications.

Cover soil shall be spread smoothly and evenly to a minimum depth of 4 inches and to the satisfaction of the Owner's Representative. All stones, root wads, and objectionable objects protruding from the surface of the cover soil shall be removed prior to seeding and/or fabric placement. The Contractor shall make every effort to keep cover soil out of the channel bed. Seed shall be broadcast over the cover soil, according to requirements set forth in Subsection 328 - Streambank Seeding, of these Specifications, prior to compacting the cover soil.

Areas to be covered by coir fabric shall be graded to a smooth condition free from protruding rocks, sticks, and other debris which may prevent a smooth application or damage the fabric.

Care shall be taken to remove all objects that would interfere with application or damage the fabric materials.

The fabric wrapped lift shall be shaped to the slope angles shown on the Drawings with smooth transitions between varying slopes. The Contractor shall handle the fabric and soil materials in a manner which does not damage the fabric or deposit soil material in the stream channel. Fabric shall be installed evenly, smoothly, and taut under the supervision of, and to the satisfaction of, the Owner's Representative.

No foot traffic or equipment shall be allowed on the completed fabric wrapped lifts. Damaged erosion fabric shall either be replaced or patched as directed by the Owner's Representative. Patches shall overlap the affected area by a minimum of two feet. Repairs and fabric replacements shall be performed at no additional cost to the Owner.

At locations where the reconstructed channel abuts construction exclusion areas, the fabric wrapped lift, Type 1 Stone toe material, and streambed fill material shall be placed and constructed in such a manner so as to create a smooth transition between the two. .

D. COMPACTION REQUIREMENTS

1. Streambank Subsoil. Subsoil material shall be placed in lifts with a maximum thickness of 12 inches and compacted to a minimum Standard Proctor Dry Density (SPDD) of 85% per AASHTO T99 or ASTM D698 test methods.

2. Streambank Cover Soil. Cover soil material shall be placed in a single lift with a minimum thickness of 4 inches and compacted to a minimum SPDD of 80% per AASHTO T99 or ASTM D698. Care must be taken to not compact the cover soil to greater than 85% density to promote vegetation growth.

E. CONSTRUCTION TOLERANCES

Finish grade tolerances shall be as follows:

1. The subgrade for the channel bed shall be excavated to within plus 0.1 foot to minus 0.1 foot of grade and plus 0.2 foot to minus 0.2 foot of lines.

2. Cover soil shall be placed to a minimum depth of 4 inches. Cover soil shall not be placed to a depth greater than that which would impede with proper placement of coir fabric.

3. Streambed fill material shall be placed to within plus 0.1 foot to minus 0.1 foot of grade and plus 0.2 foot to minus 0.2 foot of lines.

4. Within the upper reach of channel (Station 0+00 to 12+00), differences in channel invert elevations between segments of reconstructed channel and the existing channel (construction exclusion areas) shall not be greater than 0.2 foot. If the

design elevation for the top of streambed fill material differs by more than 0.2 foot from the adjoining segment of existing channel, a gradual transition shall be constructed between the two segments. This transition shall have a maximum longitudinal channel grade of 0.004 ft./ft. It will be necessary to construct the transition entirely within the reconstructed channel side of the junction in order to avoid work within construction exclusion areas.

5. Within the upper reach of channel (Station 0+00 to 12+00), differences in channel lines between segments of reconstructed channel and the existing channel (construction exclusion areas) shall not be greater than 0.5 foot. If lines differ by more than 0.5 foot from the adjoining segment of existing channel, a gradual transition shall be constructed between the two segments. It will be necessary to construct the transition entirely within the reconstructed channel side of the junction in order to avoid work within construction exclusion areas.

F. FIELD QUALITY CONTROL

Quality assurance testing will be performed by the Owner's Representative to insure compliance with the Specifications and Drawings.

END OF SUBSECTION 205

SECTION 300: SOIL PREPARATION, AMENDMENTS, AND SEEDING

SUBSECTION 315: ORGANIC SOIL AMENDMENT

315.01 GENERAL

A. DESCRIPTION

The Contractor shall incorporate organic material (compost) into cover soils that do not meet the specified 3.0% organic material content. The organic material incorporation shall be complete and uniform as approved by the Owner's Representative. It will be the Contractor's responsibility to furnish the organic material necessary to be equivalent to the quantity required (tons) on a dry weight basis.

315.02 MATERIALS

A. COMPOST

Compost material shall be certified "weed seed free" and shall have a carbon-to-nitrogen ratio (C:N) of 30:1 (+/- 10%). No inert materials or additives will be allowed to be combined with the compost product. The compost material shall not exceed the following concentrations for metals:

Arsenic:	41 mg/kg	Mercury:	17 mg/kg
Cadmium:	39 mg/kg	Nickel:	420 mg/kg
Copper:	1,500 mg/kg	Selenium:	100 mg/kg
Lead:	300 mg/kg	Zinc:	2,800 mg/kg

Target ranges for Nitrogen (N) and Phosphorous (P) concentration of the compost are as follows:

Nitrogen:	100 to 200 mg/kg
Phosphorous:	133 to 233 mg/kg

Target ranges for the minimum biomass or density of microorganisms are specified as follows:

Total Bacteria:	>100 μg/g (dry weight of compost)
Total Fungi:	>100 μg/g (for composts having a high wood component)
Protozoa:	>50,000 individuals per gram (dry weight)
Nematodes:	>20 individuals per gram (dry weight)

The Owner's Representative shall make all final determinations on the acceptability of compost material that does not meet specified target ranges, and shall reserve the right to reject compost material not meeting the target ranges.

B. SUPPLIERS

Two known suppliers of compost within the area include:

Big Butte Compost, Inc. 63 ½ West Broadway Butte, MT 59701 Phone: (406) 782-0190 Fax: (406) 782-5866	EKO-KOMPOST, Inc. P.O. Box 9168 Missoula, MT 59807 Phone: (406) 721-1423 Fax: (406) 721-7526

Suppliers must be approved by the Owner's Representative prior to delivery of material to the project site.

C. SAMPLES/SUBMITTALS

The Contractor shall be required to test representative samples of the compost and provide the test results to the Owner's Representative for approval of the product prior to application and incorporation of compost into cover soils. A minimum of one sample/test per 40 tons of compost delivered shall be required. Each sample must be tested for levels of all constituents specified in Section A above, including metal concentrations, concentrations for Carbon (C), Nitrogen (N), and Phosphorous (P), and density of specified microorganisms.

315.03 CONSTRUCTION REQUIREMENTS

A. GENERAL

Furnish, uniformly apply and incorporate compost into cover soils at the specified dry weight basis (if organic amendment is necessary to meet the 3.0% organic matter content).

B. ORGANIC MATTER CONTENT

The quantity of organic matter per cubic yard of cover soil will be dependent upon the organic matter content and the moisture content of the specific compost product. Soil material in Borrow Area 10 (BA 10) is considered to have **no** organic content (i.e., 0%).

The steps necessary to determine the amount of compost that will be required to meet the organic matter content in the cover soil generally include the following:

1. Calculate the total weight of a 4" layer of cover soil over the specified application area, based on a soil density of 2,500 pounds/cubic yard.

2. Determine the dry bulk density of the compost. The dry bulk density is defined as the dry weight/wet weight (x 100).

3. Determine the % organic content of the **dry** material. The method used to determine organic matter content of the compost shall be ASTM D 2974 - Standard Test Methods for Moisture, Ash, and Organic Matter of Peat and Other Organic Soils, or the Loss-On-Ignition (LOI) Method (this method is very similar to ASTM D 2974, and is commonly used by many laboratories).

4. The dry bulk density (determined in step #2) is multiplied by the % organic content (determined in step #3) to calculate the amount of dry organic matter per unit volume (i.e., cubic yard).

5. Using the total weight of cover soil required (determined in step #1), calculate the

total weight of organic matter needed to achieve the 3% requirement (total weight of cover soil multiplied by 0.03).

6. Divide the total weight of organic matter required (determined in step #5) by the dry organic matter content/cubic yard (determined in step #4) to arrive at the total number of cubic yards of compost required.

C. APPLICATION

The Contractor shall apply the compost in a uniform manner over the cover soil. Compost shall be applied with standard agricultural-type spreader machines or other approved application equipment.

D. INCORPORATION

Following amendment application, the soil shall be ripped to a depth of 4 inches. The soil shall then be tilled to a depth of 4 inches using a disc, rototiller, or other suitable equipment. Multiple tilling equipment passes may be required to achieve adequate incorporation. Adequate incorporation, as determined by the Owner's Representative, will be a complete and uniform mixing of the compost and cover soil to a depth of 4 inches.

E. SAMPLES/SUBMITTALS

The Contractor shall be required to test representative, in-situ samples of the cover soil after organic amendment (compost) incorporation, and provide the test results to the Owner's Representative for approval. A minimum of one sample/test per 500 tons of placed cover soil shall be required. Each sample must be tested for organic matter content (dry weight basis) of the cover soil.

END OF SUBSECTION 315

SUBSECTION 328.00: STREAMBANK SEEDING

328.01 GENERAL

A. DESCRIPTION

Seed shall be installed in all streambank planting zones at specified rates. Work shall consist of purchase, storage, installation and care of seed through the completion of construction and plant installation. The seed will be used on reconstructed streambanks covered with erosion control fabric.

328.02 MATERIALS

A. GENERAL

Seed shall consist of dormant seed propagules of specified native species of herbaceous plants. A seed mix comprised of a mixture of a variety of species will be used. All seed shall comply with requirements of Montana State Law.

The specified seed mix shall be healthy and vigorous and free of noxious weed seeds. Seeds that have become wet, moldy, or otherwise damaged, or do not meet the Specifications, will be rejected by the on-site Plant Supervisor. Replacement of this material shall be at no cost to the Owner.

B. SEED MIX

A single seed mix suited for the range of conditions expected for the project site has been developed. The species and quantities of seed required are summarized in the table below. These seed quantities assume no wastage. Seed is measured, and shall be provided in pounds of pure live seed (PLS).

Common Name	Botanical Name	SeedingRate (PLS lbs./acre)
slender wheatgrass	*Agropyron trachycaulum*	5.0
mannagrass	*Glyceria grandis*	4.0
alkali cordgrass	*Spartina gracilis*	4.0
Baltic rush	*Juncus balticus*	0.5
*wild licorice	*Glycyrrhiza lepidota*	0.5
*broad-leaf bluebell	*Mertensia ciliata*	0.5
*yellow monkeyflower	*Mimulus guttatus*	0.5
*American vetch	*Vicea americana*	0.5

* these species may only be available through Western Native Seed, listed below.

C. SUPPLIERS

Three pre-approved suppliers of seed include:

Granite Seed Company	Wind River Seed	Western Native Seed
Phone: (801) 768-4422	Phone: (307) 568-3361	Phone: (719) 539-1071
Fax: (801) 768-3967	Fax: (307) 568-3364	Fax: (719) 539-6755

Alternate suppliers must be approved by the Owner's Representative.

D. STORAGE

Seed shall be stored in a cool, dry environment (50-70°F, with less than 60 percent relative humidity) until application.

E. SUBMITTALS

The contents of each bag of seed delivered shall be clearly labeled and a list of the species components of the seed mix, including the following information, shall be supplied upon delivery of seed.

1. The common name, genus, species and subspecies (when applicable).
2. The amount of Pure Live Seed (PLS) of each species in each seed mix.
3. The percent viability of each species in each seed mix.
4. The total percentage by weight of other seeds.
5. The total delivered weight, in pounds, of each seed mix.
6. The state and county of origin of each species of seed used in mixes.
7. The name and address of the seed supplier.

328.03 CONSTRUCTION REQUIREMENTS

A. GENERAL

The Contractor shall provide all equipment, labor and materials necessary to obtain and install the quantities and species of seed called for in this specification.

B. SEEDING PERIOD

The streambank seed mix shall be installed after placement of streambank cover soils and prior to application of streambank erosion control fabric. Seeding shall not occur between May 15 and September 30.

C. INSTALLATION

This seed mix shall be applied to the reconstructed streambanks by broadcast seeding with approved hand operated seeding devices. Broadcast seeding rate is 15.5 pounds of seed mix per acre (or 8 oz. per 1,000 sq. ft.). Any areas to be seeded shall be seeded in two directions to insure even application. The first phase shall proceed from the downstream end of a given segment of stream to the upstream end. The second phase shall proceed from the upper end to the downstream end. The seed mixes shall be well mixed before and during application. Following seeding, the cover soil shall be compacted per Subsection 205 - Reconstructed Channel, followed by installation of coir fabric over the seeded areas.

END OF SUBSECTION 328

SUBSECTION 330.00: MULCH

330.01 GENERAL

A. DESCRIPTION - This work shall consist of covering and processing specified seeded areas with a mulch of the stipulated materials.

B. SUBMITTALS - The following submittals are required in accordance with the Supplementary Conditions:

- Manufacturer's specifications and material content for mulch products.
- Manufacturer's recommended application methods and rate.

330.02 MATERIALS

A. GENERAL - Mulching materials used on the project shall be those stipulated in the Special Provisions or stipulated as items in the Bid Proposal and described hereafter.

1. On projects which require a specific mulch, that type will be shown on the Bid item, i.e., "Vegetative Mulch" or "Wood Fiber Mulch", and the type specified will be the only type accepted for use.

2. On projects which can be mulched equally well by any one of several types, the Bid item will be "Mulch" and the Special Provisions will specify the types acceptable. The Contractor will have the option of selecting which one of the specified types he will use. However, once selected, only one type of mulch will be used throughout the project.

B. VEGETATIVE MULCH - This type of mulch material shall be composed of grass hay, wheat straw, rye straw, or barley straw, in that order of preference.

1. Grass Hay. This type of mulch material shall be composed primarily of perennial grasses at least 10 inches The grass hay mulch shall contain greater than 70% grass by weight and shall not contain greater than 10% alfalfa, crested wheatgrass or yellow sweet clover. Grass hay is subject to the Engineer's approval and must be "Montana Noxious Weed Seed Free Hay" provided by a certified supplier.

2. Straw. This type of mulch material shall be clean grain straw, at least 10 inches, shall be "Montana Noxious Weed Seed Free" straw and shall not contain greater than 5% cereal seed by weight, i.e., seed heads. Written confirmation from a certified supplier will be required.

Chopped or ground material is not acceptable. The mulch material is not acceptable if it is musty, moldy or rotted, or if it contains seedbearing stalks of noxious weeds. It shall be free of stones, dirt, roots, stumps or other foreign material.

C. FABRICATED MULCH - Fabricated mulch acceptable to the Owner shall be made of jute, burlap or kraft paper string. It shall be a material made and commonly used for the purpose of preventing erosion of soil surfaces.

D. FABRICATED NETTING - Fabricated netting shall be made up of jute, burlap, kraft paper string or similar products. It may be made up on the project or prefabricated. The material must be approved prior to use, and if required, samples submitted. It shall be installed as determined by the Engineer.

E. WOOD FIBER MULCH - Wood fiber mulch shall consist of specially prepared wood fibers and shall be processed in such a manner that it will not contain any growth or germination inhibiting factors. Fiber shall not be produced from recycled material such as sawdust, paper, cardboard, or residue from pulp and paper plants. The fiber shall be dyed an appropriate color to facilitate visual metering during application. The mulch shall be of such a consistency that after being combined in a slurry tank with water and other approved additives, the fibers in the material will be uniformly suspended to form a homogeneous slurry. During application the material shall produce a mat-like net covering the grass seed. Wood fiber shall be supplied in packages. Each package shall be marked by the manufacturer to show the air-dry weight content. All mulch material must be acceptable to the Owner. If requested by the Owner, the Contractor shall submit a signed statement certifying that the material furnished has been laboratory and field tested and that it meets requirements and intents specified. Wood fiber mulch shall be as manufactured by Weyerhaeuser Company or approved equal.

F. PAPER FIBER MULCH - Paper fiber mulch shall consist of waste paper, containing at a minimum 85% by weight cellulose fiber. The material may not contain any germination- or growth-inhibiting factors nor particles of metal, plastic, or non-biodegradable materials. Organic matter (oven dry) as determined by ASTM D-586 shall be at least 95%, and pH range shall be between 5.5 and 7.5.

The fiber must be dyed with a non-toxic green tracer or non-toxic green dye may be added when slurrying with water. When slurried with water and fertilizer, the mulch shall remain in uniform, homogeneous suspension while agitated.

When applied by hydraulic means to the ground surface, the paper fiber mulch must form a strong moisture-retaining mat capable of holding seed in contact with the soil without smothering the seed.

Mulch must be supplied (dry) in individual packages, each clearly marked to show the air-dry weight and contents. In the packaged form, mulch moisture cannot exceed 15% by weight.

Paper fiber mulch shall be as manufactured by Thermoguard Co., or approved equal.

G. ORGANIC MULCH - Organic mulch shall be a neutral pH organic produce formulated from grass/straw by-products, and shall be processed specifically for mulching purposes. Processing shall be in such a manner that the organic mulch not contain stalks or seeds of noxious weeds or grasses, or any growth or germination inhibiting factors. To facilitate visual metering during application, a non-toxic water soluble green colored dye shall be added to the water. The mulch shall be of such a consistency that after being combined in a slurry tank with water, dye and other approved additives, the mulch material will be uniformly suspended to form a homogeneous slurry. Upon application the material shall produce a mat-like net covering the grass seed. Organic mulch shall be supplied in packages. Each package shall be marked by the manufacturer to show the air-dry weight content. All mulch material must be acceptable to the Owner. If requested by the Owner, the Contractor shall submit a signed statement certifying that the material furnished has been laboratory and field tested and that it meets requirements and intents specified.

H. TACKIFIER - Tackifier shall be a biodegradable organic formulation processed specifically for the adhesive binding of mulch. The tackifier shall uniformly disperse when mixed with water and not be detrimental to the homogeneous properties of the mulch slurry. Any tackifier which has been moisture damaged or damaged by other means will not be acceptable. Tackifier may

be added either during the manufacturing of the mulch or incorporated during mulch application.

Organic soil and mulch tackifier for use in hydraulically planting of grass seeds, flowers, or woody tree seeds, or stolon, either alone or in combination with fertilizer, wood fiber mulch and other approved additives, shall consist of specifically blended compatible hydrocolloids. Starch-based tackifiers are unacceptable.

The soil and mulch tackifier shall be supplied in easily disposable packages containing 5, 20, or 40 pounds of material having an equilibrium air-dry moisture content at time of manufacture of 8%, plus or minus 2%, with a minimum water-holding capacity of 6 1/2 times by weight of dry material.

The organic soil and mulch tackifier shall have the additional characteristics of hydrating and dispersing in circulating water to form a homogeneous slurry and remain in such a state in the hydraulic mulching unit, or adequate equal, with the specified, or other approved materials.

Soil and mulch tackifier shall be applied at a minimum rate of 40 pounds per acre on slopes 2:1 or flatter, or at 80 pounds per acre, or more on slopes steeper than 2:1, or at manufacturer's recommendations, approved by the Engineer.

When applied, the organic soil and mulch tackifier shall form a loose chain-like protective film, but not a plant inhibiting membrane, which will allow moisture to percolate into the underlying soil, while helping "stick" seeds, fertilizer and other specified materials to the soil surface during germination and initial seedling growth, after which the organic soil and mulch tackifier shall breakdown by microbial action.

.03 CONSTRUCTION REQUIREMENTS

A. GENERAL - Mulch, when required, must be applied to seeded areas not more than 24 hours after seeding regardless of the type used. The Contractor does not mulch within 24 hours after seeding, the Contractor may be required to re-seed the project at no additional cost to the Owner. Mulch shall not be applied in the presence of free surface water, but may be applied upon damp ground. Mulch shall not be applied to snow-covered ground surfaces.

Mulch shall not be applied to areas having a substantial vegetative growth, such as grasses, weeds and grains. Areas not to be mulched shall be determined by the Engineer. Mulching shall not be done during adverse weather conditions or when wind prevents uniform distribution. Application,if after seeding, shall be in a manner to not seriously disturb the seedbed surface. All roadway structures and facilities shall be protected and kept undamaged from application of bituminous material and other operations. Any such material deposited on such structures or facilities shall be removed, at the expense of the Contractor, to the satisfaction of the Engineer.

Additional mulching may be required in accordance with summer erosion control procedures as noted in the Special Provisions.

The Contractor shall remove any equipment tracks on the seedbed prior to final mulching. The Contractor shall use a rake, small harrow or other acceptable means to remove the tracks.

B. APPLICATION OF VEGETATIVE MULCH - Vegetative mulch shall be applied after seeding and fertilizing is completed unless otherwise specified in the Special Provisions. The mulch

shall be applied in a uniform manner by a mulch spreader, at the rate specified in the Special Provisions or Drawings. The mulch spreader shall be designed specifically for this type of work. The vegetative material shall be fed into the mechanical mulch spreader at an even, uniform rate.

When asphalt or a tackifying agent is used as a binder for vegetative mulch, it shall be applied at the rate specified in the Special Provisions or Drawings. It shall be evenly distributed over the vegetative material as it emerges from the blower discharge or it may be hydraulically applied directly following mulch application. Uneven distribution, caused by inadequately powered or improperly adjusted equipment, poor workmanship, erratic material feed or discharge, or similar causes within the Contractor's control, shall be corrected. The quantity of asphalt or tackifying agent specified is subject to increase or decrease as determined in the field by the Engineer.

Straw or native hay shall be uniformly spread at the rate specified on the Drawings, or in the Special Provisions. Unless otherwise specified by the Engineer, straw or hay shall be anchored into the seedbed by using a mulch crimper. Straw or hay shall have a minimum length of 10 incheshall be pliable. If straw breaks during crimping, it shall be sprinkled with water, not soaked, to facilitate placement.

The mulch crimper, specifically designed for this type of work, shall have round, flat (not angled), notched blades of these approximate dimensions: 1/4-inch thick by 18 inches in diameter and spaced 8 inches apart. The crimper shall have sufficient weight to force the vegetative mulch a minimum of 3 inches into the soil and shall be equipped with disc scrapers. Mulch crimping shall be done on all slopes capable of being safely traversed by a tracked vehicle. All mulch crimping shall be done perpendicular to the flowline of the slope.

C. APPLICATION OF FABRICATED MULCH AND FABRICATED NETTING - Fabricated mulch shall be laid on the areas specified on the Drawings or designated by the Owner and securely fastened to the ground by wire staples, wooden pegs, or other satisfactory devices.

D. APPLICATION OF WOOD FIBER MULCH, OR ORGANIC MULCH - Wood fiber mulch or organic mulch shall be applied by means of hydraulic equipment which utilizes water as the carrying agent. A continuous agitator action, that keeps the mulching material and approved additives in uniform suspension, must be maintained throughout the distribution cycle. The pump pressure shall be capable of maintaining a continuous non-fluctuating stream of slurry. The slurry distribution lines shall be large enough to prevent stoppage.

The discharge line shall be equipped with a set of hydraulic spray nozzles which will provide an even distribution of the mulch slurry to the seedbed. Mulching shall not be done in the presence of free surface water resulting from rains, melting snow, or other causes.

The Contractor shall start at the top of the slope and work downward. If necessary, he may be required to use extension hoses to reach the extremities of slopes.

E. FINISHING - Prior to final acceptance of the project, the Contractor shall immediately remulch any area from which the original mulch may have been washed or blown. If the original seedbed and seeding is damaged due to the displacement of the mulching material, the seedbed shall be repaired and reseeded before remulching. The operations described in this paragraph shall be at the Contractor's expense if the damage is due to his negligence.

SUBSECTION 340.00: EROSION CONTROL MAT

340.01 GENERAL

A. DESCRIPTION - This work item shall consist of furnishing, placing, and stapling erosion control mat to the ground surface on the slopes designated by the Engineer and as shown on the Drawings.

B. SUBMITTALS - The Contractor shall provide the following submittals in accordance with the Supplementary Conditions:

- One-square-foot sample of each type of mat and sample staple.
- Manufacturer's catalog cuts and material specifications for the erosion control mat and staples.
- Installation manuals.

340.02 MATERIALS

A. EROSION CONTROL MAT - The erosion control mat shall be curled wood excelsior or straw with photodegradable extruded plastic mesh or woven jute fabric. Erosion control mats shall be furnished in continuous rolls of 30-feet or greater with a minimum width of 4 feet. The erosion control mat shall be as manufactured by North American Green, American Excelsior Company, Belton Industries, or approved equal. Mat type and grade (model) shall be as specified in the Special Provisions.

B. STAPLES - Staples shall be made of wire, 0.091-inch in diameter or greater and have a "U" shape with legs 6 to 8 inches in length and a 1 to 2-inch crown. On slopes steeper than 3:1, staples shall have at least 8 inches legs.

340.03 CONSTRUCTION REQUIREMENTS

A. GENERAL - The area to be covered with the erosion control mat shall be as shown on the Drawings and areas designated by the Engineer. The area to be covered shall be properly prepared, fertilized, seeded, and approved by the Engineer before the mat is applied. Those areas to which the mat is to be applied shall not be mulched unless otherwise specified in the Special Provisions.

Erosion control mat may be placed either perpendicular or normal to the slope and shall be "trenched in" at the uphill end of the mat as shown on the Drawings and according to the manufacturer's recommendations. Additional trenching and backfilling of mat may be required to insure adequate stability. The mat shall be stapled on 2-foot centers in trench bottoms.

When the erosion control mat is unrolled, the finer mesh size side or fiber side of the mat will be placed in contact with the soil (not applicable to woven jute fabric). The mat will not be stretched and will lay loosely on the soil surface to achieve maximum contact with the soil. Mat edges shall be butted snugly against each other and stapled. Ends shall be overlapped, and end joints shall be staggered as recommended by the manufacturer. Staples shall be placed according to manufacturer's recommendations, as shown on the Drawings and additionally as requested by the Engineer. Wire staples shall be driven into the ground for the full length of the legs.

Mat installation, if after seeding, shall be in a manner as to not seriously disturb the seedbed surface. If the seedbed is seriously disturbed, the Engineer may require re-preparing the seedbed and reseeding at no additional cost to the Owner.

SUBSECTION 345.00: COIR FABRIC MATERIALS

345.01 GENERAL

A. DESCRIPTION

This item shall consist of furnishing, placing, and securing a woven coir fabric to the ground as specified, and as part of bioengineered bank treatments, as shown on the Drawings. Coir fabric material shall be used during construction for work in the following Subsection.

Subsection 205 - Reconstructed Channel

B. SUBMITTALS

The Contractor shall provide the following submittals to the Owner's Representative:

- One-square-foot sample of each type of fabric and a sample stake.
- Name, address, and phone number of the supplier(s).
- Name of contact person at supplier.
- Manufacturer's material specifications.

345.02 MATERIALS

A. REFERENCES

ASTM D1777 Thickness of Geotextile
ASTM D3776 Mass per Unit Area of Geosynthetics
ASTM D4595 Tensile Strength and Elongation of Geotextile

B. NON-WOVEN COIR FABRIC

Non-woven coir fabric shall be used as an inner fabric layer in the fabric encapsulated soil (FES) lift to be constructed as part of the reconstructed channel bank treatment between Stations 0+00 and 12+00, as shown on the Drawings. The non-woven fabric shall be a composition blanket (100% coconut fiber), held together with an organic netting sewn with organic thread on 1.5-inch centers with the following minimum average roll properties:

Property	Test Method	Criteria
Thickness	ASTM D1777	0.25 inch
Tensile Strength (dry)	ASTM D4595	200 lbs./ft. x 125 lbs./ft.
Weight	ASTM D3776	8 oz./sq.yd. (280 gms/m)
Open Area	Measured	50%
Roll Width	Measured	4 meters (13.1 feet)

Pre-Approved: The pre-approved fabric is RoLanka BioD-OCF30. If this product is unavailable, Palm Fiber CF-072B is an acceptable alternative.

C. WOVEN COIR FABRIC (700 grams/meter)

Woven coir fabric (700 grams/meter) shall be used to cover the reconstructed channel banks for erosion protection. The woven fabric shall be a high-strength coir (100% coconut fiber), continuously woven mat (i.e., without seams) with the following minimum average roll properties:

Property	Test Method	Criteria
Thickness	ASTM D1777	0.30 inch
Tensile Strength (dry)	ASTM D4595	80 lbs./in.^{2} x 35 lbs./in.^{2}
Weight	ASTM D3776	20 oz./sq.yd. (700 gms/m)
Open Area	Measured	50%
Roll Width	Measured	4 meters (13.1 feet)

Pre-Approved: Pre-approved fabrics (if they are without seams) are DeKoWe 700, and Palm Fiber KoirMat 700.

D. WOODEN STAKES

Stakes for installation of all coir fabric shall be 24 inches long and shall have a top (head) dimension of at least 1.5 inches in one axis (thickness) and 3.0 inches in the second axis (width). Stakes shall be constructed by diagonally rip cutting a 2" x 4" piece of lumber, from top to bottom, across the 4-inch wide surface such that the top meets the minimum width and thickness specifications.

E. SUPPLIERS

Approved suppliers for coir products include, but are not limited to, the following:

KoirMat/Nedia Enterprises	DeKoWe/Roscoe Steel	RoLanka Int'l., Inc.
Attn: Cory	Phone: (888) 725-6999	Phone: (800) 760-3215
Phone: (406) 542-0345	FAX: (718) 740-1049	FAX: (770) 961-1480

345.03 CONSTRUCTION REQUIREMENTS

A. GENERAL

Refer to Subsection 205 - Reconstructed Channel, of these Specifications for instructions regarding preparation of the ground surface prior to fabric placement.

END OF SUBSECTION 345

SECTION 500: MISCELLANEOUS SITEWORK

SUBSECTION 510.00: OWNER'S REPRESENTATIVE'S FIELD OFFICE

510.01 GENERAL

A. DESCRIPTION - This work shall consist of furnishing, equipping, and maintaining specified services for an Owner's Representative's field office, including all necessary power, utilities, and insurances. The field office shall be maintained and serviced until the project is complete. The field office shall be ready for occupancy by the Owner's Representative within 21 days of Notice to Proceed. The office shall conform to local building codes. The Contractor shall obtain all necessary permits for temporary use of the trailer at the construction site.

510.02 MATERIALS & EQUIPMENT

A. FIELD TRAILER - The field office shall be one 12-foot by 60-foot trailer, minimum, divided into four rooms. Trailer shall be weather tight construction with floor, walls, ceiling fully insulated. Ceiling shall be 8-feet high with acoustical tile. Interior walls shall be 3/8-inch architectural wooden panels. All floors shall be covered with industrial grade vinyl composition tile.

B. EQUIPMENT - The trailer shall be provided with two exterior doors with Medeco lock systems, or equal, keyed alike. The Owner's Representative shall be provided with four sets of keys. At each entrance, a wooden stairway with railing and 6-foot by 6-foot platform shall be provided. Each room shall have a door. A portable toilet will be set up outside of the trailer within 50 feet waking distance. The portable toilet will be maintained by the Contractor.

C. HEATING/COOLING SYSTEM - The trailer shall be provided with central heating and air conditioning. The system shall be capable of maintaining an interior temperature of 70 degrees F when the exterior temperature is -20 degrees F and interior temperature of 75 degrees F when the exterior temperature is 100 degrees F. The system shall be thermostatically controlled with a thermostat located on an interior partition.

D. WATER - The Contractor will provide potable drinking water delivered to the trailer. The Contractor will be responsible for maintaining the water supply until the project is complete.

E. ELECTRICAL SYSTEM - Installation shall include entrance connectors, grounding, enclosed fused service switches and branch circuit fuse boxes. Separate circuits shall be provided for lighting and other electrical operated items. Minimum circuit size shall be two conductor No. 12 AWG. Use heavier conductors where required. The entire electrical system and trailer shall be properly grounded.

F. LIGHTING AND OUTLETS - Lighting shall be provided by fluorescent ceiling fixtures furnishing at least 20 foot-candles at desk height, uniform throughout. Each room shall be provided with a wall switch for veiling fixtures. Each area shall be provided with duplex convenience outlets as required by local code.

G. MOVABLE EQUIPMENT AND FURNITURE - Field office furniture and equipment may be previously used if in excellent condition, subject to Owner's Representative's approval. The field office shall be furnished with the following furniture and new equipment:

4 - 60-inch by 30-inch desk with file drawers and five drawers, all lockable, and upholstered swivel type chair with arms

1	-	60-inch by 30-inch drafting table with drawer and stool
1	-	48-inch by 120-inch conference table
12	-	Armless side chairs (stacking type)
3	-	File cabinet, four drawer, legal size, Hon No. HN-315C, or equal
5	-	Wastebaskets
2	-	Plan storage racks, rolling 10 stick
1	-	Storage cabinet, lockable, 72-inches high by 36-inches wide by 18-inches deep
2	-	Fire extinguishers, type B:C
2	-	Steel bookcases, four shelves high, Hon No. HN-S48 ABC, or equal
1	-	Electric bottled water dispenser with hot and cold outlets and adequate water bottles
1	-	First aid kit
2	-	Smoke detectors with batteries
1	-	Dry erase boards, aluminum frame, 36-inch by 60-inch, markers and eraser
1	-	One-half cubic foot microwave oven
1	-	Six cubic foot refrigerator
1	-	Copier

H. MAINTENANCE AND SERVICE - The Contractor shall provide maintenance and service of the field office until the project is complete. Maintenance and service shall include, but not be limited to, weekly janitorial services and all repair and cleaning of lavatory, drinking water, light, heat, and air conditioning equipment.

I. INSURANCE - The Contractor's leasing company shall provide fire insurance, extended coverage and vandalism, malicious mischief and burglary, and theft insurance coverage for the trailer and contents in the amount of $100,000. Proof of coverage shall be provided by the Contractor to the Owner.

510.03 REMOVAL

A. The Contractor shall completely remove all temporary materials and equipment when their use is no longer required.

B. Clean and repair damage caused by temporary installations or use of temporary facilities.

C. Remove all field offices, contents, and services from the site. Remove foundations and debris and grade area to approximate preconstruction grades. The Owner's Representative's field office shall become the property of the Contractor.

SUBSECTION 511.00: ABANDON EXISTING MONITORING WELLS

510.01 GENERAL

A. DESCRIPTION - This work shall consist of abandoning existing monitoring wells according to the current Montana Board of Water Well Contractors regulations. Wells shall be abandoned such that they neither produce water nor serve as a channel for vertical movement of water. Any obstructions or debris which may interfere with abandonment operations shall be removed prior to sealing. Pertinent well data appear in the project special provisions. Wells shall be abandoned by filling with graded bentonite. The Contractor shall attempt to remove the well casings during abandonment.

510.02 MATERIALS

A. BENTONITE - Size-graded bentonite shall be used for well abandonment. Bentonite shall be graded to have 100% of particles pass through the 3/8" screen and all particles retained on the 1/4" screen.

510.03 CONSTRUCTION REQUIREMENTS

A. The Contractor shall abandon the existing wells by filling with bentonite clay chips. Bentonite shall be poured into the well hole as the casing is removed to no more than 3 feet below the approximate level of the excavated construction grade of the surrounding ground. Bentonite shall be poured in such a manner to prevent bridging. Water shall be added to hydrate the bentonite if the hole is dry. After construction excavation to grade, the casing (if remaining) shall be cut off at a depth of three feet below grade, the hole backfilled with on-site fill material, and compacted to 90% of maximum dry density. The ground surface shall then be restored to grade as indicated on the construction drawings, safe for animals and humans. If the excavation grade is within four feet of the bottom of a well, the entire well shall be removed by excavation, backfilled with on-site material, and compacted to 90% of maximum dry density.

510.04 RECORD KEEPING

A. Complete and accurate records of the abandonment procedure for each well shall be maintained by the Contractor. Included in this record shall be:

(1) Depth of back filled material and method of placement;

(2) Quantity of sealing material used;

(3) Total depth of well before abandonment; and

(4) Other remarks.

Copies of all records shall be provided to the Owner's Representative.

SUBSECTION 520.00: FARM FENCE

520.01 GENERAL

A. DESCRIPTION - This work shall consist of the construction of barbed wire fence and gates in accordance with these Specifications and the Standard Drawings and in reasonably close conformity with the lines and grades shown on the Drawings or established by the Engineer.

The type of fence covered by this specification is designated as "Farm Fence - Type F-3, F-4, or F-5" as shown on the Standard Drawings.

Fence type shall be specified in the Proposal or Special Provisions and will include wood (W) or metal (M) line post designation (example: F-4M is a 4-strand wire fence with metal line posts).

Diagonal fence panels and 1x1 rod enclosures will be specified as separate items if so noted in the Special Provisions, Drawings, or Proposal.

520.02 MATERIALS

All materials used in the construction of fence shall be new materials meeting the following requirements and those shown on the Standard Drawings. Posts for new fences shall be as specified in the Special Provisions.

A. BARBED WIRE - Barbed wire shall be zinc-coated, steel barbed wire meeting the requirements of ASTM A 121. Breaking strength of strand wire shall be not less than 950 pounds. Barbs shall be uniformly spaced from 4 to 5 inches apart. Barbed wire shall be Class 1, zinc-coated 12 1/2 gauge unless specified differently in the Special Provisions. Barbed wire shall be 2-point barbed unless specified otherwise.

B. BRACE WIRE - Brace wire shall be 9 gauge, soft, and galvanized.

C. STAPLES AND NAILS - Wire staples of the barbed U-shaped type shall be not less than 9 gauge, 1-3/4 inches long. Nails shall be of the size specified in the Standard Drawings and shall be large enough to complete the nailing requirements.

D. TIE WIRE - Tie wires shall be not lighter than 12 1/2 gauge. Commercial fasteners supplied with the wire may be used when approved. All shall be galvanized.

E. METAL FENCE STAYS - Metal fence stays shall be of standard make. They shall be fabricated from 9 1/2 gauge wire base and twisted to form a 2-wire unit.

F. METAL POSTS - Metal fence posts shall meet the requirements of ASTM A 702. The metal shall be a good commercial-quality steel with a maximum carbon content of 0.82%. Posts and anchor plates shall be galvanized or painted. Galvanizing shall be in accordance with AASHTO M 111 (ASTM A 123). Painting shall be in accordance with good manufacturing practice.

Line posts shall be Tee, H, channel, or U-bar section and shall have corrugations, knobs, notches, holes, or stubs so placed and constructed as to engage a substantial number of fence line wires in proper position.

Posts shall have a nominal weight of 1.33 pounds per foot (exclusive of anchor plates). Length shall be 6 feet 6 inches.

Each line post shall be provided with a tapered steel anchor plate weighing not less than 0.67 pounds and securely fastened to the post in such a position that its top edge will be 2 to 3 inches below the ground surface when the post is set to prescribed depth.

G. WOOD POSTS AND BRACE RAILS - Wood posts and brace rails shall be made from Western Larch, Lodgepole Pine, Ponderosa Pine, or Douglas Fir. They shall have the bark removed, be well-seasoned, sound, and straight-grained.

Posts for wire fences shall be finished either natural round or square sawn. Line posts shall be 4 inches minimum diameter, naturally round, or a minimum of 4 inches by 4 inches square sawn. Corner, end, gate, pull, and brace posts shall be 6 inches minimum diameter, naturally round, or 5 1/2 inches by 5 1/2 inches square sawn.

Wood posts and brace rails for farm fence may be multi-sided. Regardless of number of sides, the minimum cross-sectional area shall be at least 13 square inches for line posts and brace rails and at least 29 square inches for terminal and panel posts. Wood line post lengths shall be 7 feet 0 inches, and wood panel post and brace rail lengths shall be 8 feet 0 inches.

A post with a bow of more than 2 inches in 7 feet will be rejected.

Wood posts for farm fence shall be treated with a minimum 5% by weight pentachlorophenol solution or Chromated Copper Arsenate (CCA), Type B or C, or Ammoniacal Copper Arsenate (ACA) conforming to AWPA Standards. Treatment must be done in such a manner and with a carrying agent that the preservative will penetrate the wood at least 1/2 inch or full sap. Treatment shall extend to a minimum length of 36 inches for line posts and 48 inches for other posts. The treated end shall be placed in the ground. Brace rails shall not be treated. Post treatment must be performed at an approved plant.

Posts that are to be driven in the ground shall be tapered in about 8 to 12 inches to about a 1-inch point on the lower end. The upper end shall be tapered for a minimum of 4 inches to a round top with a minimum diameter of 3 inches for line posts and 5 inches for terminal and panel posts. This taper is included in the specified post length. Tapering shall be done prior to treatment. No extra length at the top will be required, provided the Contractor can drive the posts without damaging the upper end. Tops of gate posts shall not be tapered when gate closers are to be attached.

H. GATES FOR FARM FENCE - Gates for farm fences shall be of the material and construction shown on the Standard Drawings.

I. DEADMAN OR ANCHOR - A deadman shall weigh at least 150 pounds. It shall be a precast concrete block, cast-in-place concrete block, or approved equal.

J. CONCRETE POST FOUNDATIONS - Concrete for post foundations shall be required as shown on the Drawings and shall be class C-3000 as specified in Subsection 710.00, Structural Concrete.

K. MISCELLANEOUS - Nuts, bolts, fittings, and other hardware used in the construction of fences and gates shall be galvanized in accordance with ASTM A 153 or B 454 (Class 50).

520.03 CONSTRUCTION REQUIREMENTS

A. CLEARING AND LEVELING - As determined by the Engineer, irregularities in the ground line upon which the fence is to be constructed shall be corrected by use of a dozer or with other equipment that will perform a satisfactory job.

All trees, shrubs, brush, rock, and other obstacles that interfere with proper construction of the fence shall be removed by the Contractor and disposed of in a manner satisfactory to the Engineer.

In performing the operation of clearing and leveling, a minimum amount of terrain shall be disturbed.

B. POSTS AND BRACES - Post holes and excavations shall be excavated on the lines shown on the Drawings to the depths shown on the Standard Drawings for Farm Fence.

Wood posts may be driven when so prepared. All damaged posts shall be satisfactorily repaired or rejected.

Posts that are cut or trimmed shall be treated with 2 coats of preservative. The preservative shall be a minimum 5% by weight pentachlorophenol solution or Chromated Copper Arsenate (CCA) Type B or C, or Ammoniacal Copper Arsenate (ACA) conforming to AWPA standards.

Brace rails shall be notched and securely nailed to wood posts. In no case will notching of the wood posts be allowed.

Metal posts that are not required to be set in concrete may be driven.

All posts shall be backfilled in 6 inches lifts, and each lift solidly tamped and compacted.

All posts shall remain solidly in place after backfilling or driving has been completed.

C. ERECTING FENCE - After the posts and braces have been firmly set, the barbed wire shall be placed, tightly stretched, and fastened to the posts.

Tension shall be applied in accordance with the wire manufacturer's recommendations. Stretching by a motor vehicle will not be permitted. The power must be by or through a mechanical stretcher or device designed for such use.

Fence wire shall be wrapped around terminal posts and fastened to itself with at least four turns. Fence wire, in general, shall be placed on the side of the post opposite the work being undertaken. On curves, the wire shall be placed so the wire force is against the posts.

U-shaped staples shall be driven diagonally across the wood grain so that both points do not enter between the same grain. In depressions where wire uplift occurs, staples shall be sloped with points slightly upward.

On level ground and over knolls, staples shall be sloped slightly downward. Wire shall be stapled tightly at corner and end posts. On line posts the staples shall not be driven so tightly as to prevent movement of the wire. In no case shall staples be driven so tightly as to damage the wire.

At grade depressions, alignment angles, and other places where stresses tending to pull posts from the ground or out of alignment are created, the wire fence shall be snubbed or guyed at the critical points by brace wire attached to each horizontal line of fence wire. The combined ends of the brace wires shall be firmly attached to a "deadman" buried not less than 2 feet in the ground or to an approved anchor at a point that will best serve to resist the pull of the wire fence. Deadmen also may be fastened to posts. The locations to use deadmen shall be as determined by the Engineer and in accordance with these Specifications.

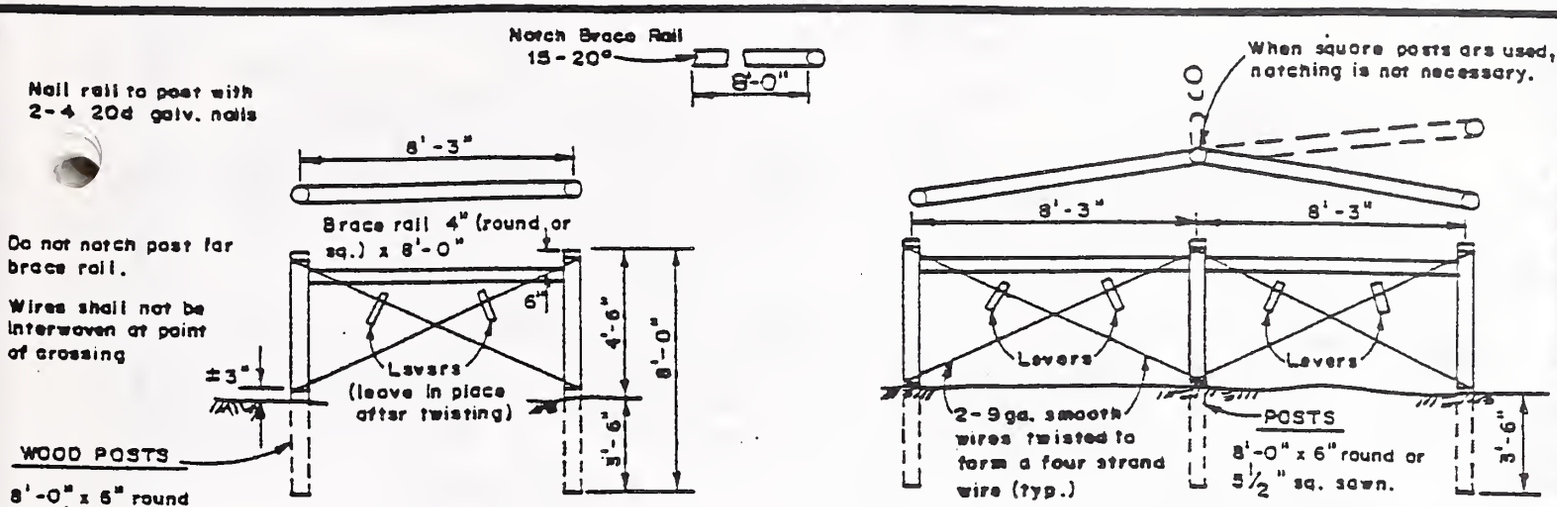
Fence panels shall be set at the locations designated on the Drawings or staked in the field. Wood terminal posts shall be used when panels are not required.

Gates shall be constructed in accordance with the Standard Drawings.

Any corner or change of angle greater than 14 degrees must have a double panel for runs less than 660 feet and a corner panel for runs greater than 660 feet.

Diagonal fence panels shall be installed when specified in the Special Provisions or on the Drawings.

Upon completion, the fence shall be true to line and grade, all posts shall be vertical and firm, all wire shall be taut, and the completed fence shall be acceptable in all respects. Gates shall operate freely and properly. No openings shall be left that will permit stock or other animals to pass through the fence.


Notch Brace Rail 15-20°
8'-0"
Nail rail to post with 2-4 20d galv. nails
8'-3"
Brace rail 4" (round or sq.) x 8'-0"
Do not notch post for brace rail.
Wires shall not be interwoven at point of crossing
6"
±3"
Levers (leave in place after twisting)
4'-6"
8'-0"
3'-6"
WOOD POSTS
8'-0" x 6" round or 5½" sq. sawn
When square posts are used, notching is not necessary.
8'-3"
8'-3"
Levers
Levers
2-9 ga. smooth wires twisted to form a four strand wire (typ.)
POSTS
8'-0" x 6" round or 5½" sq. sawn.
3'-6"

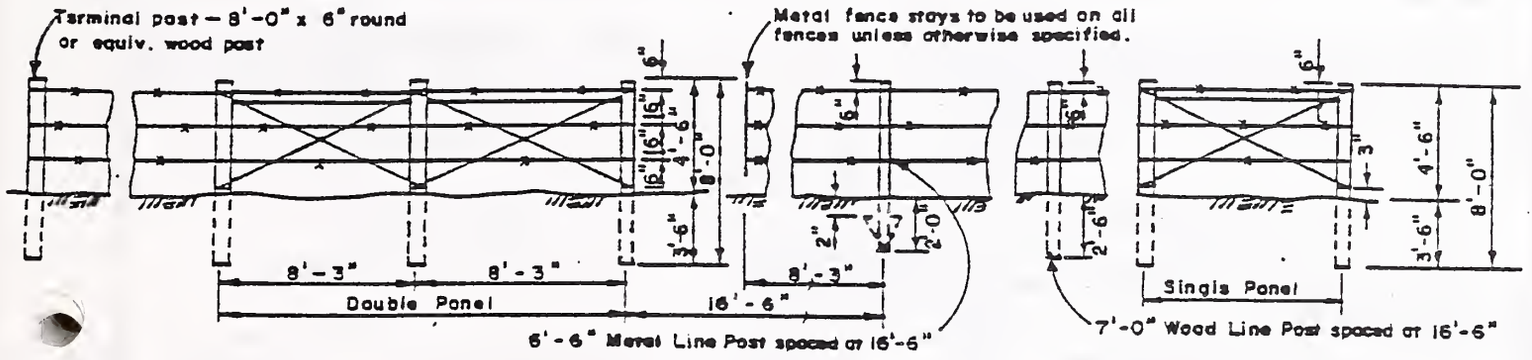
SINGLE PANEL

Use for pulling, stretching, changes in vertical alignment or panels on a run less than 660'.

DOUBLE PANEL

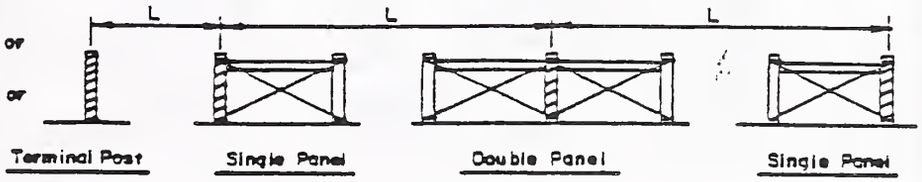
Use for corners, where runs are less than 660', changes in horizontal alignment or panels on a run 660'-990'.

PANEL DETAILS



Fence Type	L = run	Panels Req'd.
Barbed	66' or less	Terminal Post
	66' - 660'	Single
	660' - 990'	Double

8'-0" x 6" round or equivalent post. Use for runs 66' or less.



NOTE: Tie off wire on shaded post.

NOTES:

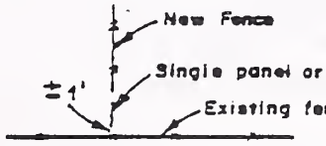
1. All fence wire to be placed on side of post opposite work area except curves, the wire shall be placed on the outside of the curve. In areas subject to high velocity winds and moving debris, wires may all be placed on windward side of posts, except on curves.
2. Post spacing measured generally parallel to ground.
3. Line post shall normally be spaced 16'-6" apart. Also 16'-6" from brace or panel posts.
4. 36" wire stay to be placed halfway between posts, excepting panels.
5. A deadman may be a concrete block, a cast-in-place concrete block, a rock or other approved object, weighing at least 150 pounds and covered at least 2 feet.
6. Type F-3M: 3 Strand barbed wire fence with Metal Line Posts.
7. Type F-3W: 3 Strand barbed wire fence with Wood Line Posts.

Double Panel

Use where runs are less than 660 feet.

Corner Panel

Use where runs are 660 feet to 990 feet.

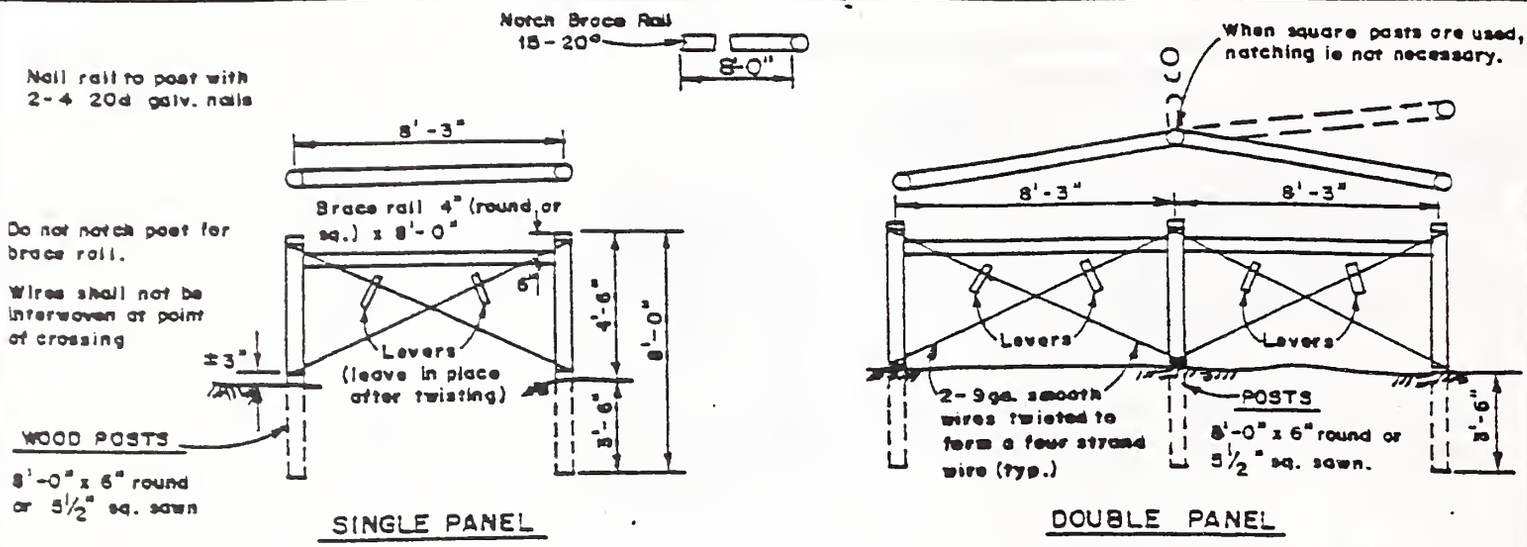


Intersection New Fence With Existing Fence

STATE OF MONTANA
DEPARTMENT OF STATE LANDS

TYPE F-3
FARM FENCE

STANDARD DRAWING NO. 520.01



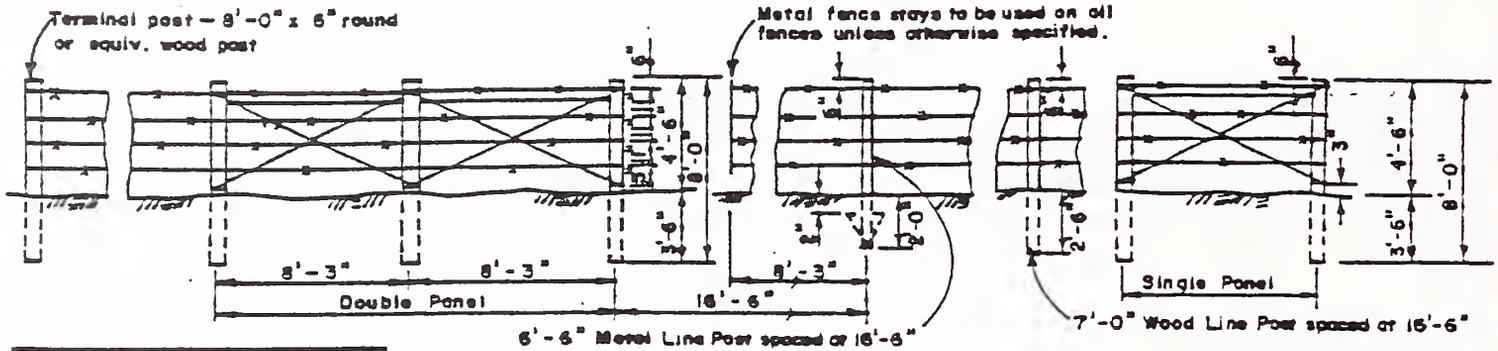
SINGLE PANEL

Use for pulling, stretching, changes in vertical alignment or panels on a run less than 660'.

DOUBLE PANEL

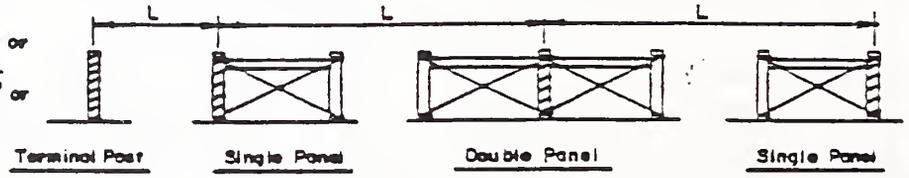
Use for corners, where runs are less than 660', changes in horizontal alignment greater than 14° or panels on a run 660'–990'.

PANEL DETAILS



Straight Run Requirements		
Fence Type	L= run	Panels Req'd.
Barbed	66' or less	Terminal Post
	66' – 660'	Single
	660' – 990'	Double

8'-0" x 6" round or equivalent post. Use for runs 66' or less.



NOTE: Tie off wire on shaded post.

NOTES:

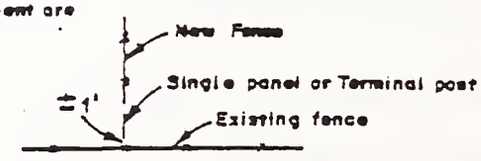
1. All fence wire to be placed on side of post opposite work area except curves, the wire shall be placed on the outside of the curve. In areas subject to high velocity winds and moving debris, wires may all be placed on windward side of posts, except on curves.
2. Post spacing measured generally parallel to ground.
3. Line post shall normally be spaced 16'-6" apart. Also 16'-6" from brace or panel posts.
4. 36" wire stay to be placed halfway between posts, excepting panels.
5. A deadman may be a concrete block, a cast-in-place concrete block, a rock or other approved object, weighing at least 150 pounds and covered at least 2 feet.
6. Type F-4M: 4 Strand barbed wire fence with Metal Line Posts.
7. Type F-4 W: 4 Strand barbed wire fence with Wood Line Posts.

Double Panel

Use where runs are less than 660 feet or where changes in horizontal alignment are greater than 14°

Corner Panel

Use where runs are 660 feet to 990 feet.



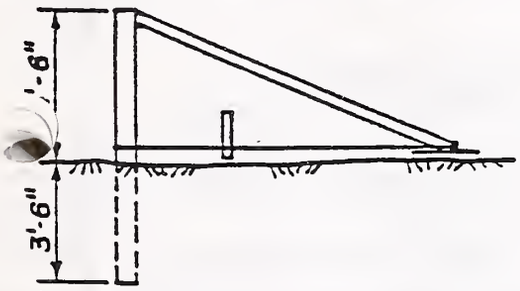
Intersection New Fence With Existing Fence

REVISED 5/88

STATE OF MONTANA
DEPARTMENT OF STATE LANDS

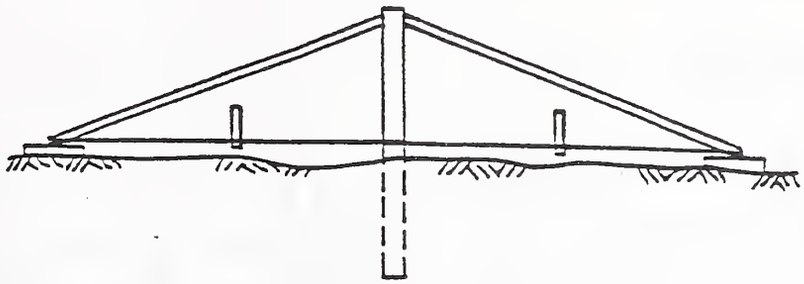
TYPE F-4 FARM FENCE

STANDARD DRAWING NO. 520.02



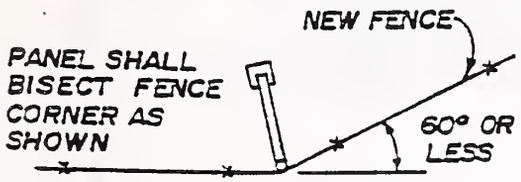
SINGLE DIAGONAL PANEL

USE FOR GATE OPENING, END OF RUN, AND ANGLES 60° OR LESS AS SHOWN

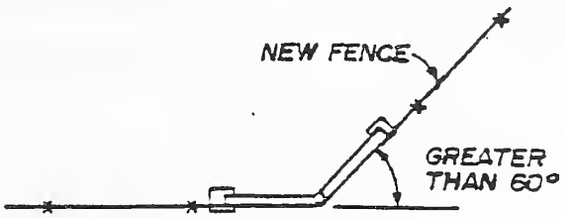


DOUBLE DIAGONAL PANEL

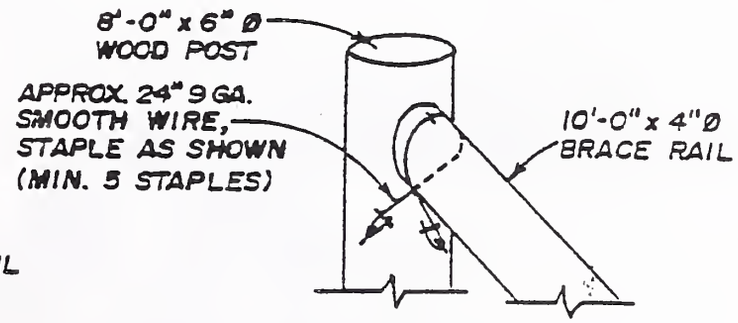
USE FOR ANGLES GREATER THAN 60° AS SHOWN



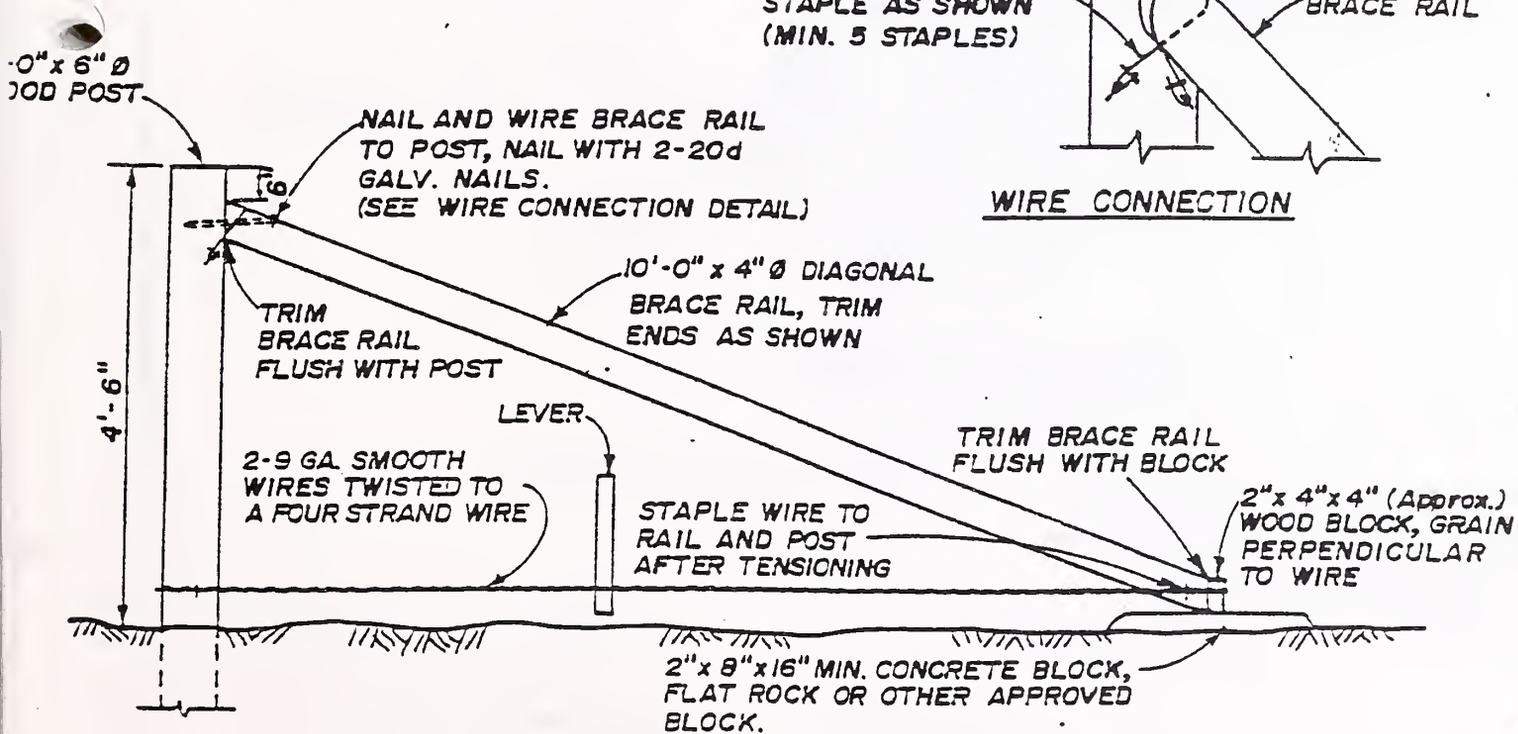
SINGLE DIAGONAL PANEL AT FENCE CORNER



DOUBLE DIAGONAL PANEL AT FENCE CORNER



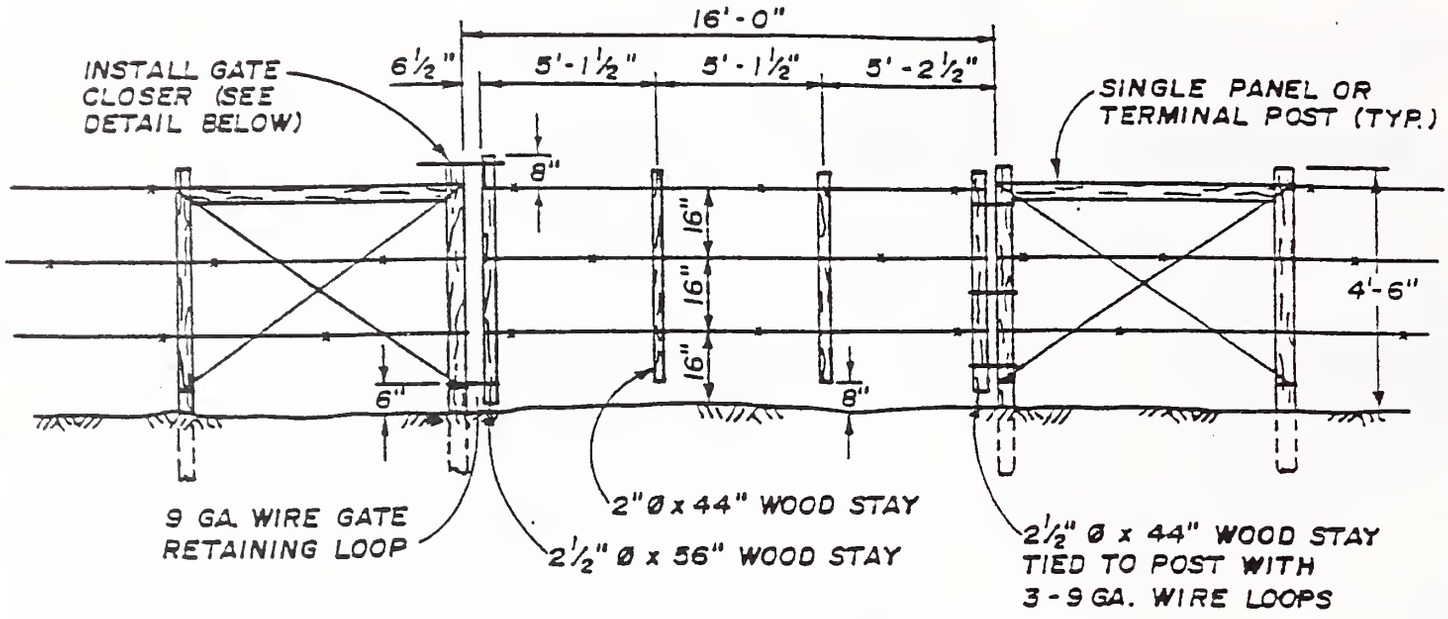
WIRE CONNECTION


-0" x 6" Ø OOD POST
NAIL AND WIRE BRACE RAIL TO POST, NAIL WITH 2-20d GALV. NAILS. (SEE WIRE CONNECTION DETAIL)
6"
10'-0" x 4" Ø DIAGONAL BRACE RAIL, TRIM ENDS AS SHOWN
TRIM BRACE RAIL FLUSH WITH POST
4'-6"
LEVER
2-9 GA. SMOOTH WIRES TWISTED TO A FOUR STRAND WIRE
STAPLE WIRE TO RAIL AND POST AFTER TENSIONING
TRIM BRACE RAIL FLUSH WITH BLOCK
2" x 4" x 4" (Approx.) WOOD BLOCK, GRAIN PERPENDICULAR TO WIRE
2" x 8" x 16" MIN. CONCRETE BLOCK, FLAT ROCK OR OTHER APPROVED BLOCK.

STATE OF MONTANA
DEPARTMENT OF STATE LANDS

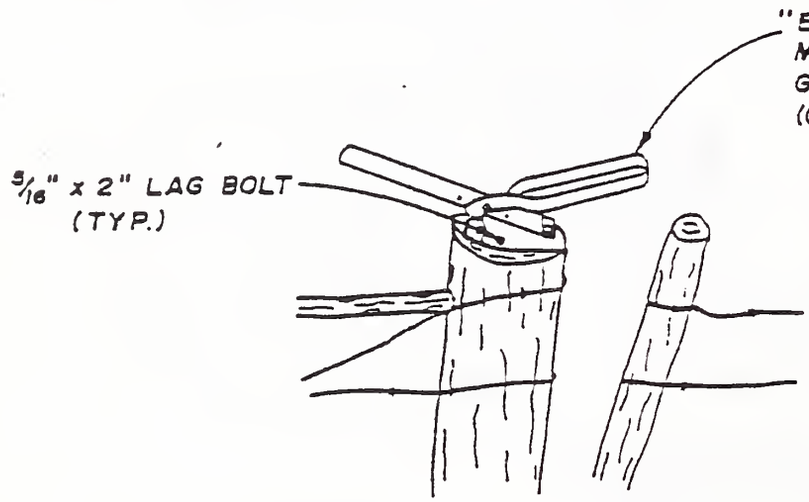
DIAGONAL FENCE PANELS

STANDARD DRAWING NO. 520.03



GATE DETAIL

NO SCALE



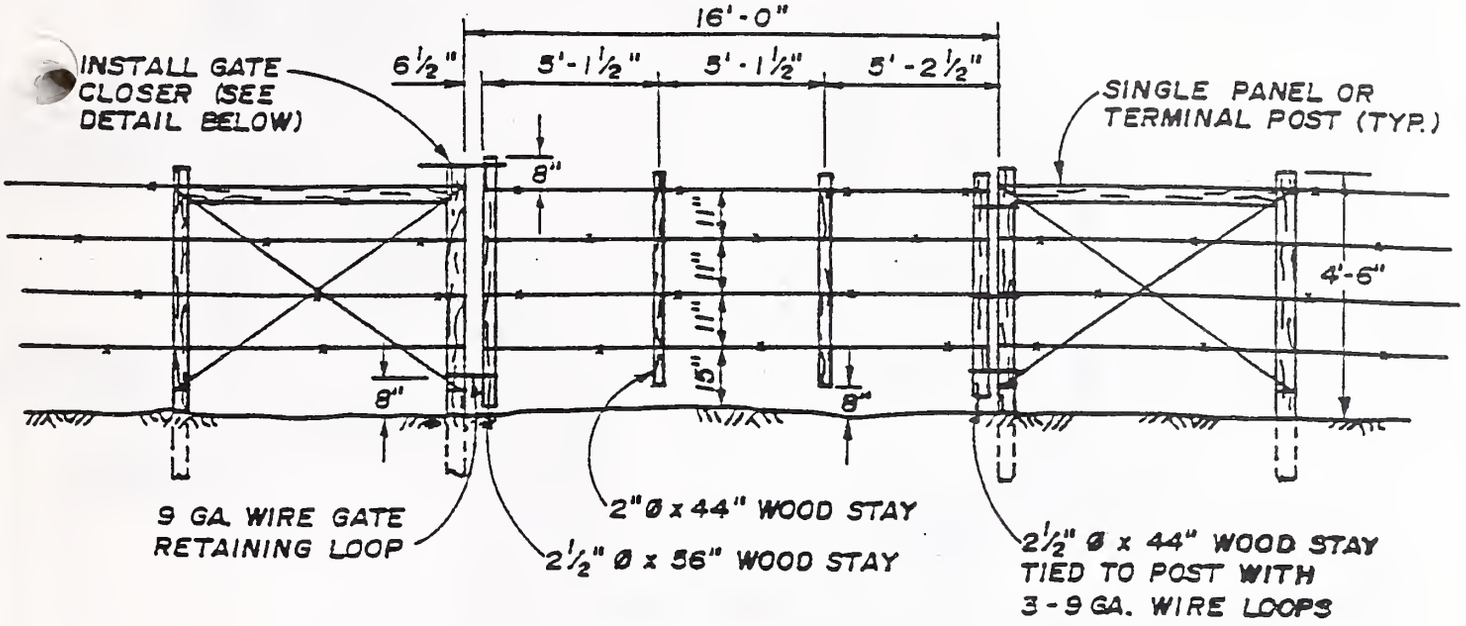
GATE CLOSER DETAIL

NO SCALE

NOTES:

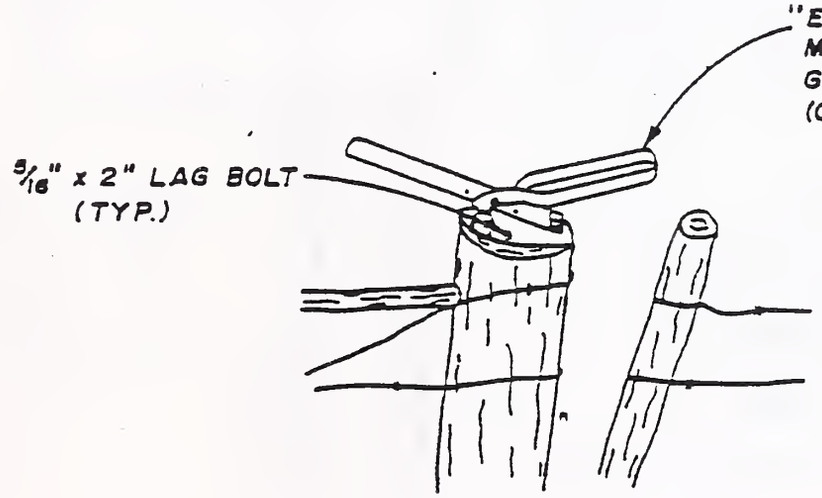
1. WIRE LOOPS TO BE STAPLED TO POST.
2. GATE WIRE TO MATCH NEW FENCE WIRE.
3. WIRE TO BE STAPLED TO STAYS.
4. COST OF CLOSER TO BE INCLUDED IN COST OF GATE.

STATE OF MONTANA DEPARTMENT OF STATE LANDS
F-3 FARM FENCE GATE
STANDARD DRAWING NO. 520.04



GATE DETAIL

NO SCALE



GATE CLOSER DETAIL

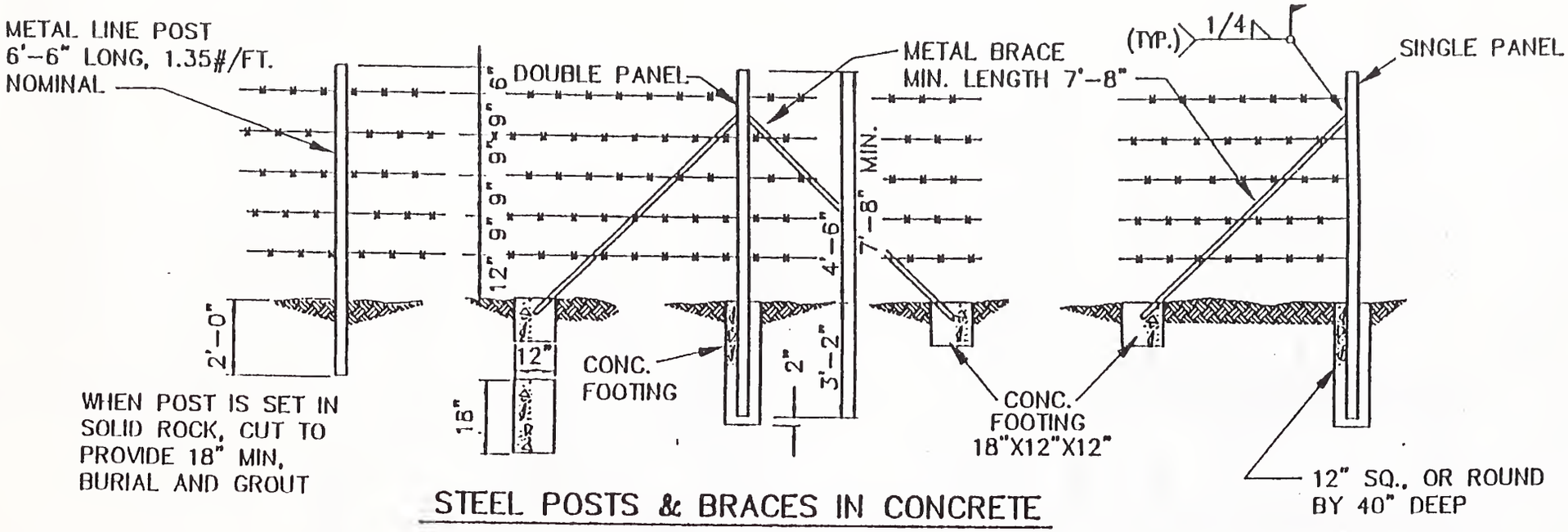
NO SCALE

NOTES:

1. WIRE LOOPS TO BE STAPLED TO POST.
2. GATE WIRE TO MATCH NEW FENCE WIRE.
3. WIRE TO BE STAPLED TO STAYS.
4. COST OF CLOSER TO BE INCLUDED IN COST OF GATE.

STATE OF MONTANA DEPARTMENT OF STATE LANDS
F-4 FARM FENCE GATE
STANDARD DRAWING NO. 520.05

REVISED 5/88



STEEL POSTS & BRACES IN CONCRETE

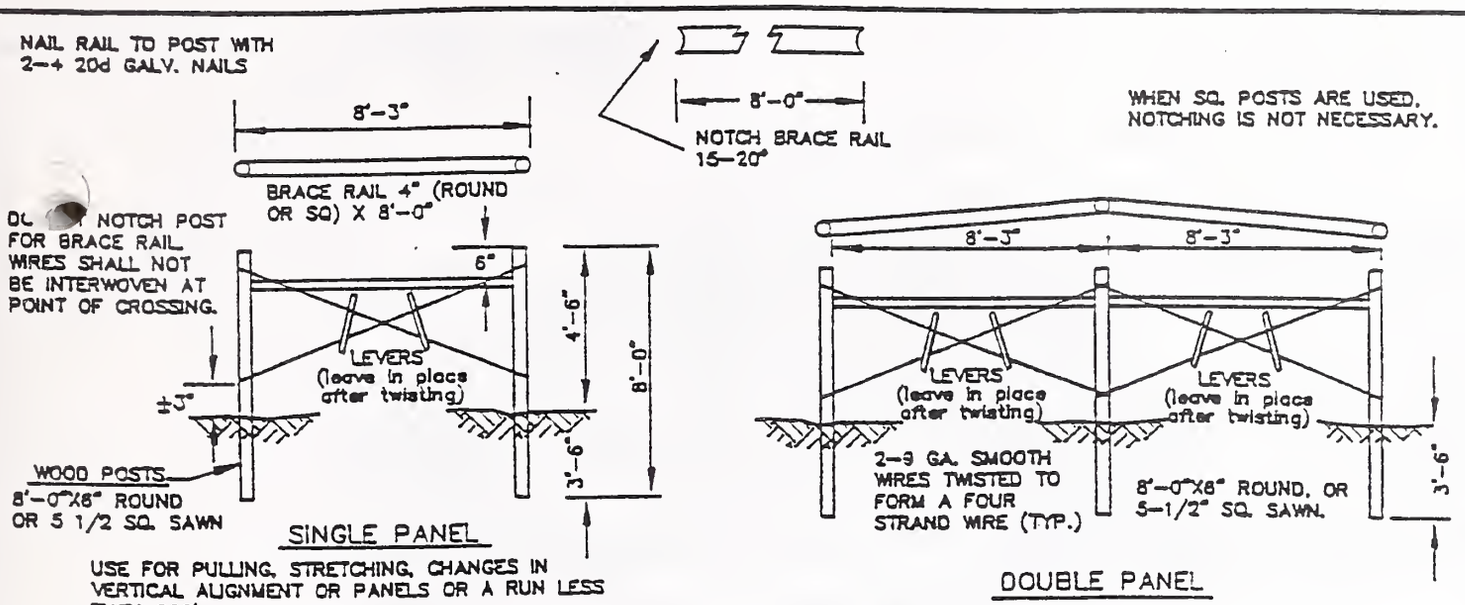
NOTES

- A DEADMAN MAY BE A CONCRETE BLOCK,A CAST-IN-PLACE CONCRETE BLOCK, A ROCK, OR OTHER APPROVED OBJECT WEIGHING AT LEAST 150 POUNDS AND COVERED AT LEAST 2 FEET.
- EACH CORNER END GATE, OR PULL POST AND EACH BRACE SHALL BE SET IN CONCRETE AND BRACED AS INDICATED.
- ALL CONCRETE SHALL BE CLASS "F", OR BETTER.
- STAPLE ALL WIRES TO WOOD LINE POSTS.
- TIE ALL WIRES TO STEEL LINE POSTS.
- STAPLE ALL WIRES TO WOOD CORNER POSTS, OR POSTS USED TO TIE-OFF ALL WIRE.
- METAL BRACES SHALL BE WELDED TO EACH CORNER, END GATE, OR PULL POST.

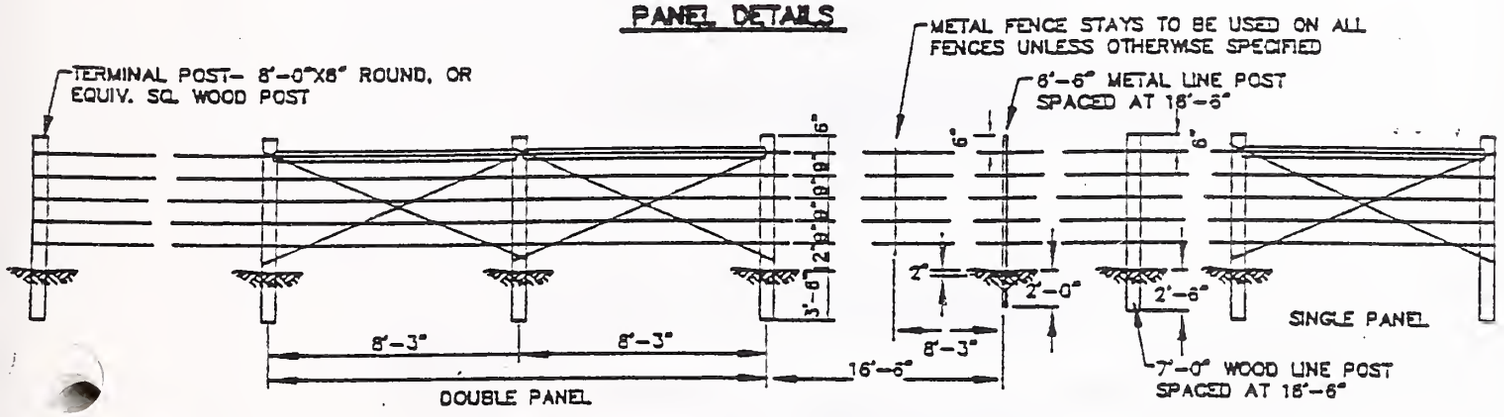
STATE OF MONTANA
DEPARTMENT OF STATE LANDS

TYPE F-5 FARM FENCE WITH POSTS IN CONCRETE

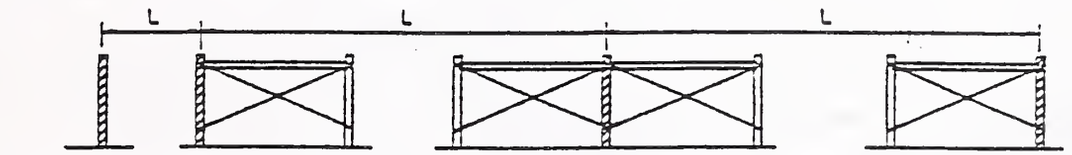
DRAWING No. 520.06


NAIL RAIL TO POST WITH 2–4 20d GALV. NAILS
8'–3"
8'–0"
NOTCH BRACE RAIL 15–20°
WHEN SQ. POSTS ARE USED, NOTCHING IS NOT NECESSARY.
BRACE RAIL 4" (ROUND OR SQ) X 8'–0"
DO NOT NOTCH POST FOR BRACE RAIL. WIRES SHALL NOT BE INTERWOVEN AT POINT OF CROSSING.
6"
LEVERS (leave in place after twisting)
±3"
4'–6"
8'–0"
3'–6"
WOOD POSTS 8'–0"X6" ROUND OR 5 1/2 SQ. SAWN
SINGLE PANEL
USE FOR PULLING, STRETCHING, CHANGES IN VERTICAL ALIGNMENT OR PANELS OR A RUN LESS THEN 660'.
8'–3"
8'–3"
LEVERS (leave in place after twisting)
LEVERS (leave in place after twisting)
2–9 GA. SMOOTH WIRES TWISTED TO FORM A FOUR STRAND WIRE (TYP.)
8'–0"X6" ROUND, OR 5–1/2" SQ. SAWN.
3'–6"
DOUBLE PANEL
USE OF CORNERS, WHERE RUNS ARE LESS THAN 660', CHANGES IN HORIZONTAL ALIGNMENT, OR PANELS ON A RUN 660'–990'.

PANEL DETAILS



FENCE TYPE	L=RUN	PANELS REQUIRED
BARBED	66' or less	Terminal Post
	66' – 660'	Single
	660' – 990'	Double



NOTE: Tie wires off at shaded post.

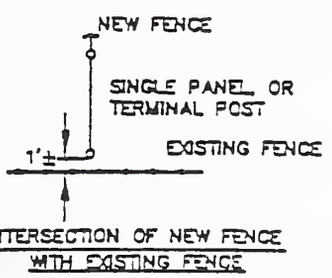
TERMINAL POST

DOUBLE PANEL

Use where runs are less than 660 feet.

DOUBLE CORNER PANEL

Use where runs or 660 feet to 990 feet.



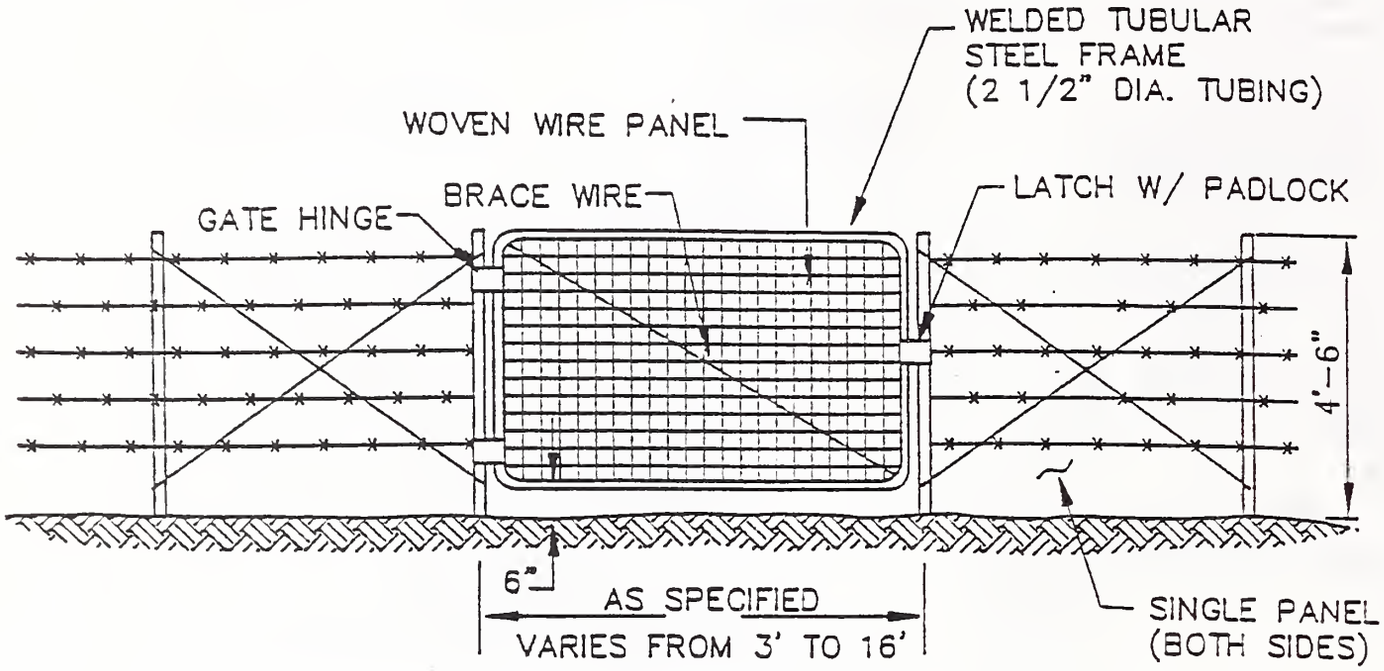
NOTES:

1. All fence wire to be placed on side of post opposite work area except curves, the wire shall be placed on the outside of the curve. In areas subject to high velocity winds and moving debris, wires may be placed on windward side of posts. Except on curves.
2. [illegible] spacing measured generally parallel to ground.
3. Line post shall normally be spaced 16'–6" apart. Also 15'–6" from brace, or panel posts.
4. .35" wire stay to be placed halfway between posts, excepting panels.
5. A deadman may be a concrete block, a cast–in–place concrete block, a rock, or other approved object, weighing at least 150 pounds and covered at least 2 feet.

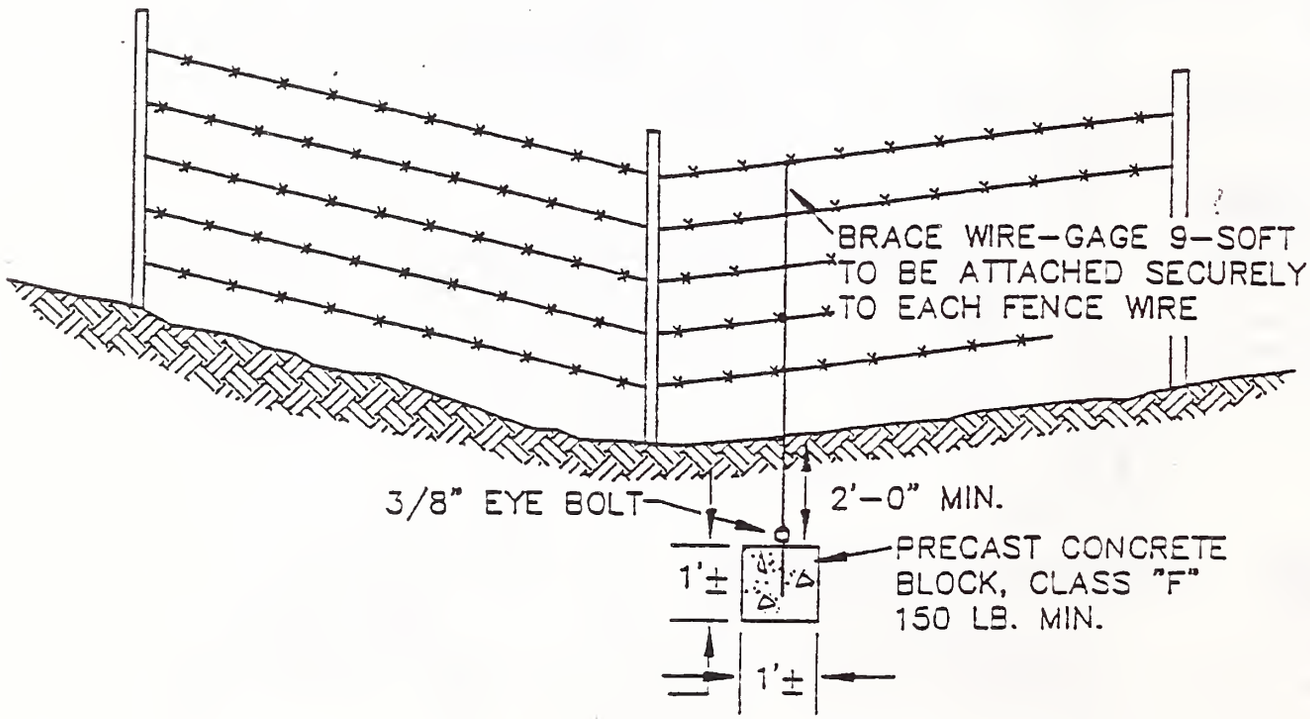
STATE OF MONTANA
DEPARTMENT OF STATE LANDS

TYPE F–5 FARM FENCE

DRAWING No. 520.07

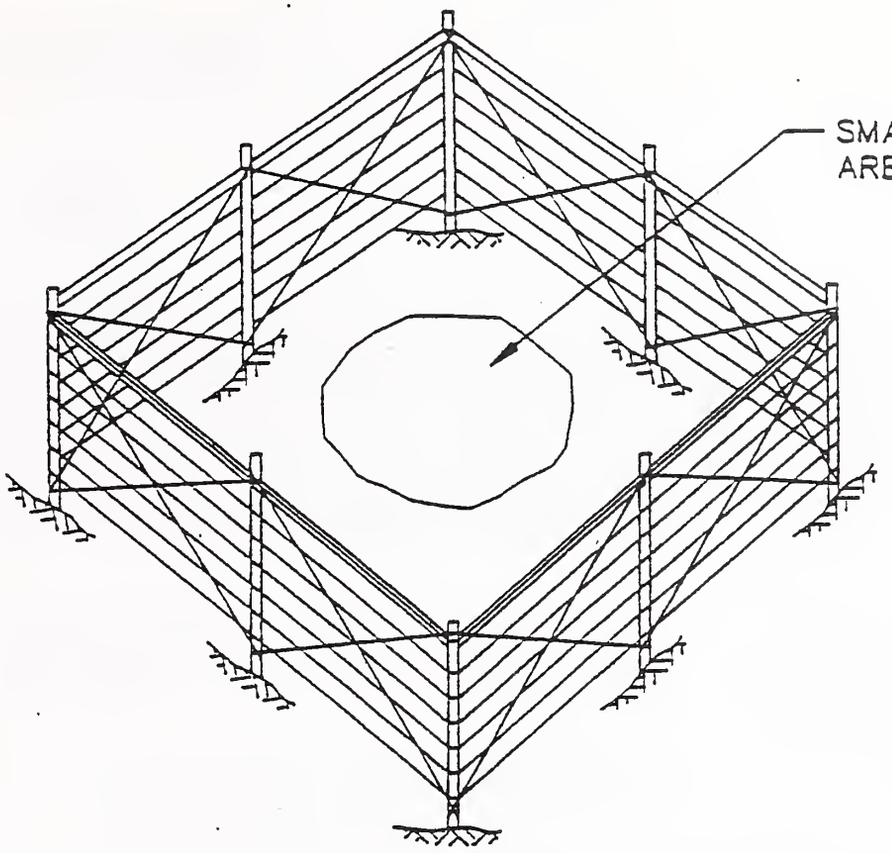


HINGED METAL GATE DETAIL
NO SCALE

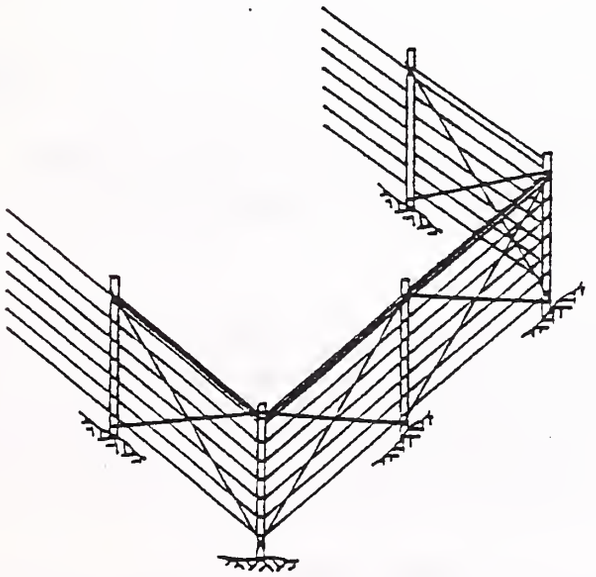


DEADMAN DETAIL
NO SCALE

STATE OF MONTANA DEPARTMENT OF STATE LANDS
DEADMAN AND GATE DETAIL
DRAWING No. 520.08



1 X 1 ROD ENCLOSURE



1 ROD END TREATMENT

STATE OF MONTANA DEPARTMENT OF STATE LANDS
MISCELLANEOUS FENCE DETAILS
DRAWING No. 520.09

SUBSECTION 525.00: GABIONS

525.01 GENERAL

A. DESCRIPTION

This work shall consist of furnishing all materials and performing all work necessary to place wire-enclosed rock (gabions) on bottoms and side-slopes of channels and as a covering material through the diversion structure spillway, as directed by the Owner's Representative. Gabions consist of mats or baskets fabricated from wire mesh, filled with stone, connected together, and anchored to the slope. Gabions shall be placed at the locations shown on the Drawings (Sheets I23 and I25).

B. RELATED WORK

Work in this Subsection shall be coordinated with work in the following, related Subsections:

Subsection 205 - Reconstructed Channel
Subsection 535 - Stone
Subsection 548 - Diversion System

525.02 MATERIALS

A. REFERENCES

ASTM A641. Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire.
ASTM A370. Standard Test Methods and Definitions for Mechanical Testing of Steel.

B. WIRE

All wire used in the fabrication of the gabions and mattresses shall be Zinc-Coated (Galvanized) Carbon Steel Wire and shall meet the requirements of ASTM A641. The adhesion of the zinc coating to the wire should be such that, when wrapped around a mandrel in accordance with ASTM A641, the zinc coating will not crack or flake to such an extent that any zinc can be removed by rubbing the wire with bare fingers.

The nominal diameter of the wire shall be 0.0866 inches. A test for elongation shall be made on a 10-inch long sample of the wire before fabrication of the mattresses. Elongation shall not be less than 12%, in accordance with the requirements of ASTM A370.

C. MESH

The wire shall be fabricated into a hexagonal, woven mesh with the joints formed by twisting each pair of wires through three half turns. The nominal mesh size is 2 ½ x 3 1/4 inches.

D. FASTENERS

Spenax fasteners to be used with galvanized wire shall be fabricated from galvanized steel wire with a diameter of approximately 0.120 inches as per ASTM A641. The wire used for the rings shall be coated in accordance with ASTM A641.

E. DIMENSIONS

Gabion Type D. This gabion type, with placement locations shown on the Drawings, shall have the following dimensions:

Nominal Width	= 3 feet
Nominal Length	= 6 feet
Nominal Thickness	= 1.5 feet

Gabion Type F. This gabion type, with placement locations shown on the Drawings, shall have the following dimensions:

Nominal Width	= 3 feet
Nominal Length	= 12 feet
Nominal Thickness	= 1.5 feet

Gabion Type G. This gabion type, with placement locations shown on the Drawings, shall have the following dimensions:

Nominal Width	= 3 feet
Nominal Length	= 6 feet
Nominal Thickness	= 1 foot

Gabion Type Z. This gabion type, with placement locations shown on the Drawings, shall have the following dimensions:

Nominal Width	= 6 feet
Nominal Length	= 12 feet
Nominal Thickness	= 1 foot

525.03 CONSTRUCTION REQUIREMENTS

A. GABIONS

Gabions shall be fabricated in such a manner that the sides, ends, lid and diaphragms can be assembled at the construction site into rectangular baskets of the sizes specified and shown on the Drawings. Gabions shall be of single-unit construction; the base, lid, ends and sides shall be either woven into a single unit or one edge of these members connected to the base section of the gabion in such a manner that the strength and flexibility at the connecting point is at least equal to that of the mesh. Where the length of the gabion exceeds one and one-half times its horizontal width, the gabion shall be divided by diaphragms of the same mesh and gauge as the body of the gabions, into cells whose length does not exceed the horizontal width. The gabion shall be furnished with the necessary diaphragms secured in the proper position on the base in such a manner that no additional tying is required at this juncture.

B. INSTALLATION

Each gabion shall be assembled by tying all untied edges with binding wire. The binding wire shall be tightly looped around every other mesh opening along the seams in such a manner that single and double loops are alternated.

A line of empty gabions shall be placed into position according to the Drawings, and binding wire shall be used to securely tie each unit to the adjoining one along the vertical reinforced edges and the top selvedges. The base of the empty gabions placed on top of a filled line of gabions shall be tightly wired to the latter at front and back.

Spenax fasteners may be used in lieu of binding wire for all fastening operations. The joint formed should be of similar quality as with binding wire and shall have no gaps between contact surfaces. All adjoining gabion units shall be connected prior to filling along the edge of their contact surfaces or just inside the selvedge or edge wire in order to obtain a monolithic structure. Spenax fasteners should be properly formed with a 9/16-inch to 5/8-inch nominal internal diameter after closure. Fasteners are to be spaced every mesh opening, or at 4-inch nominal spacing.

The gabions in any row shall be filled in stages so that local deformations may be avoided. That is, at no time shall any gabion be filled to a depth exceeding one foot more that the adjoining gabion. When a gabion has been filled, the lid shall be bent over by hand until it meets the front and sides. The lid shall then be tightly bound to the rest of the basket with the lacing wire or fasteners along all edges and internal cell diaphragms in the same manner as described before.

Gabions may be filled by hand or mechanical means. Every effort shall be made to keep voids and bulges in the gabions to a minimum in order to insure proper alignment and a neat, compact, and square appearance.

C. STONE FILL

All stone material used to fill the gabions shall be Type 2, and shall meet the gradation and material requirements in Subsection 535 - Stone, of these Specifications.

D. BANK STABILIZATION FABRIC

Bank stabilization fabric shall be placed beneath the gabions prior to their assembly and placement. Fabric shall adhere to the requirements and specifications in Subsection 650.02(c) - Bank Stabilization Fabric.

END OF SUBSECTION 525

SUBSECTION 535.00: STONE

535.01 GENERAL

A. DESCRIPTION

This work shall consist of furnishing stone materials for streambank fill, as a protective covering for streambanks, as diversion channel liner material, as a filter medium below diversion channel lining material, as a protective lining for bridge and culvert abutments, as fill material for gabions, and as bedding material (granular fill) beneath culverts. Designated areas for application of each type of stone material are shown on the Drawings.

Stone materials shall be used during construction for work in the following Subsections:

Subsection 205 - Reconstructed Channel
Subsection 548 - Diversion System

B. SUBMITTALS

The following submittals are required in accordance with the Supplementary Conditions. This information shall be submitted at least one week prior to delivery of the stone to the project site.

- A representative sample of each type of stone material.
- Results of gradation, specific gravity, and bulk density analyses for each type stone material.
- Source of the material.
- Name of the supplier and name and phone number of contact person.

535.02 MATERIALS

A. DESCRIPTION

Stone shall be hard, durable, sound, resistant to weathering and to water action; free from overburden, spoil, shale, structural defects, and organic material. The least, or nominal, dimension of any stone shall not be less than 1/3 its greatest dimension. If rounded stone or cobbles are used, they shall not be placed on slopes greater than 2H:1V. Unless otherwise permitted, the bulk density of the stone shall be at least 165 lbs./ft.^{3}, with a specific gravity of 2.65.

B. REFERENCES

ANSI/ASTM D422. Sieve Analysis of Fine and Coarse Aggregates.

C. GRADATIONS

Stone materials shall meet the following gradation requirements.

Type 1 Stone:

This stone shall be used for streambank stabilization material between Stations 0+00 and 12+00 (not including the exclusion areas shown on the Drawings) of the reconstructed channel, and for diversion channel lining material upstream and downstream of the diversion channel grade control, as shown on the Drawings. Type 1 stone shall have the following gradation. This gradation may be adjusted only with approval of the Owner's Representative.

Sieve Designation	Percent Passing
15-inch	100
12-inch	70-90
9-inch	40-60
4-inch	0-20

Type 2 Stone:

This stone shall be used for lining material within specified reaches of the diversion channel, for protection of the upstream side of the diversion structure, and as stone fill material for all gabions. Type 2 stone shall have the following gradation. This gradation may be adjusted only with approval of the Owner's Representative.

Sieve Designation	Percent Passing
10-inch	100
8-inch	70-90
7-inch	40-60
3-inch	0-20

Stream Bed Material - Reconstructed Channel:

The stone to be used for stream bed fill material within the reconstructed channel shall have the following gradation. This gradation may be adjusted only with approval of the Owner's Representative.

Sieve Designation	Percent Passing
3.5-inch	100
2-inch	70-90
1.5-inch	40-60
1-inch	15-30
0.75-inch	0-10

Gravel Filter/Granular Fill

The material to be used for filter gravel and granular fill shall have the following gradation. This gradation may be adjusted only with approval of the Owner's Representative. This material shall be used as a filter medium beneath larger stone (where specified), as a bedding material beneath culverts, and as a road surfacing material for the temporary haul road crossings of the diversion channel.

Sieve Designation	Percent Passing
1.25-inch	100
1-inch	80-100
No. 4	35-70
No. 20	10-20
No. 40	0-5

County Road - Base Course Material:

Material to be used as a base course for the County Road Crossing shall have the following gradation. This gradation may be adjusted only with approval of the Owner's Representative.

Sieve Designation	Percent Passing
2-inch	100
1-inch	50-80
No. 4	20-50
No. 200	8 (max.)

County Road - Surface Course Material:

Material to be used as a surface course for the County Road Crossing shall have the following gradation. This gradation may be adjusted only with approval of the Owner's Representative.

Sieve Designation	Percent Passing
1-inch	100
No. 4	40-70
No. 10	25-55
No. 200	2-10

END OF SUBSECTION 535

SUBSECTION 536.00: ROCK COVER

536.01 GENERAL

A. DESCRIPTION – This work item shall consist of furnishing and placing suitable rock cover material in areas designated on the Drawings and in the Special Provisions. Rock cover material shall be obtained off-site and it shall be the responsibility of the Contractor to locate a material source suitable to the Engineer.

Rock material shall consist of a revetment composed of stone and fragmented rock as a protective and erosion-resistant covering on the slopes of railroad embankments shown on the Drawings and/or established by the Engineer.

B. SUBMITTALS – The following submittals are required in accordance with the Supplementary Conditions:

- Gradation (by size and weight) and specific gravity for rock cover materials.
- Percentage of aggregate (by weight) having at least one fractured face.
- Samples of stone shall be taken in the presence of the Engineer.
- Rock cover material source location.

536.02 MATERIALS

A. GENERAL – Stone shall be hard, durable, angular in shape, resistant to weathering and to water action, free from overburden, spoil, shale, structural defects and organic material, and shall meet the gradation requirements specified. Mining wastes including waste rock, gangue, ore, veinstone or lode filling are not acceptable.

B. ROCK COVER – The type of material used shall be 3 inch minus with a maximum of 5% passing the No. 4 Sieve. The material must be classified as a well-graded gravel according to ASTM D2487. A minimum of 50% of the material will have at least one fractured face.

536.03 CONSTRUCTION REQUIREMENTS

A. ROCK COVER MATERIAL – The stone, graded so the smaller stone is uniformly distributed, shall be handled or dumped on the designated slopes to form the cross-section shown on the Drawings and as determined in the field by the Engineer. The rock shall be manipulated by hand or machine methods sufficiently to secure a regular surface and mass stability. Where the thickness of rock material is not shown on the drawings, it shall be at least 6 inches measured perpendicular to the slope. Unless otherwise shown, rock material shall extend from 1 foot below the toe of the slope to the elevation shown on the Drawings.

SUBSECTION 545.00: INCIDENTAL DEWATERING AND COFFERDAMS

545.01 GENERAL

A. DESCRIPTION

The work included in this section includes supplying, installing, maintaining, and removing when completed all necessary equipment, labor, pumps, erosion and sediment controls, and incidentals to dewater excavations for the diversion system and reconstructed stream channel and streambank construction. This work also includes supplying, installing, maintaining, and removing when completed all necessary equipment, labor, pumps, erosion and sediment controls, and incidentals to dewater the reconstructed channel and diversion system following periods of rain or snow.

B. RELATED WORK

Work in this Subsection shall be coordinated with work in the following, related Subsections:

Subsection 202 - Excavation and Embankment
Subsection 205 - Reconstructed Channel
Subsection 548 - Diversion System

C. COFFERDAM SYSTEM

A cofferdam system shall be used as a temporary dewatering method during construction of the diversion structure and for reconstructed channel bed and bank construction between Station 0+00 (upstream limit of construction) and Station 12+00 to allow work to occur under a non-flowing condition. The cofferdam system is not required for the remainder of channel construction because flows are to be routed into a diversion channel downstream of Station 12+00. The cofferdam system is not intended to be water tight or exclude all flows; rather the objectives of the enclosure are to:

1. Provide a safer and more efficient work environment for constructing the diversion structure and channel bed and banks;
2. Protect the work from flows during construction;
3. Aid in accurate placement of construction materials;
4. Prevent the separation and gradation changes which would occur during stone placement under conditions of high velocities, where flow would selectively remove smaller stone sizes; and
5. Reduce releases of sediment and sediment-laden water to Silver Bow Creek.

For channel bed and bank construction, the Contractor shall install a cofferdam system around the work site and shall relocate this system with the advancement of the work from Station 0+00 to Station 12+00. Portions of the reach between Stations 0+00 and 12+00 are to be excluded from channel construction, as shown on the Drawings, and therefore will not require placement of a cofferdam system.

The cofferdam system shall have the following physical characteristics.

1. The enclosure shall adequately surround the work area.
2. For reconstructed channel bed and bank construction, the length of the cofferdam enclosure can be sized to match the Contractor's requirements for efficiency in excavation and scheduling. However, no excavation or bed/bank construction shall occur within the creek from Station 0+00 to Station 12+00 without the protection of a cofferdam.
3. In the event that the cofferdam system is washed downstream, it shall be retrieved, if possible, within 24-hours after high flows have receded.
4. Cofferdam enclosures shall not extend into construction exclusion areas between Stations 0+00 and 12+00. The exclusion areas include: Station 0+00 to Station 2+10, Station 4+05 to 4+45, and Station 8+30 to Station 9+40; a total distance of 360 feet.

D. INCIDENTAL DEWATERING

Accommodations shall be made for incidental dewatering of the diversion system and reconstructed channel bed and bank construction. Incidental dewatering shall be deemed necessary if standing water is observed within the diversion channel or reconstructed channel excavations. Shallow collection trenches shall be constructed within the excavations to route water to sump areas, where pumps can be used to transfer this water to designated on-site sediment detention basins. Locations of the detention basins are shown on the Drawings (Sheets M6a-M6d).

E. SUBMITTALS

The Contractor shall submit a reconstructed channel and diversion system dewatering operations plan to the Owner's Representative prior to initiation of any dewatering activities. No waste water shall be discharged directly to Silver Bow Creek without written approval from the Owner's Representative. The Contractor shall be responsible for complying with all applicable Federal, State, and local water quality regulations.

The Contractor shall provide 24-hours verbal or written notification to the Owner's Representative prior to commencing any dewatering activities including, but not limited to, diversion of Silver Bow Creek into the diversion channel and all incidental dewatering operations within the reconstructed channel or diversion channel that are required to provide a work site free of standing water.

The Contractor shall prepare and submit a plan for cofferdam placement upstream of the diversion structure, and for channel construction from Station 0+00 to 12+00, for approval by the Owner's Representative. The Contractor may modify (with the Owner Representative's approval) and/or adopt the cofferdam plan shown in the Drawings and Specifications, and shall include an operating plan for flows ranging from 0 to 30 cfs, and an evacuation plan for flows up to 2,330 cfs (100-year event) in Silver Bow Creek. The Contractor shall be responsible to verify the adequacy, effectiveness, and safety of the submitted enclosure plan.

545.02 MATERIALS

A. GENERAL

The Contractor shall be responsible for supplying all supplies, equipment, and labor, in sufficient quantities, to dewater the diversion channel and reconstructed channel as necessary without delaying the construction progress. The pumping system shall have the capacity to operate continuously through the duration of the project to provide uninterrupted continuation of the Work. The Contractor shall deliver additional dewatering equipment if, in the Owner Representative's opinion, the lack of necessary equipment or labor has caused, or has the potential to cause, construction delays.

B. COFFERDAM

The cofferdam shall have the following physical characteristics.

1. The cofferdam shall have a nominal height of 5 feet. The top elevation of the barriers, installed, is estimated to range from 5,414 to 5,417 AMSL, depending on channel bed elevations along the enclosure alignment.

An approved type of cofferdam is the Port-A-Dam™ system, which consists of welded tubular steel support members and a flexible, waterproof membrane. Support members can be placed together in a linear fashion to form a water-tight diversion wall.

Information regarding this product can be obtained from the following supplier:

Port-A-Dam, Inc.
107 Drivers Lane
Laurel Springs, NJ 08021
Tel. (800) 346-4793 or (609) 875-4577

545.03 CONSTRUCTION REQUIREMENTS

A. GENERAL

The Contractor shall inspect the site on a daily basis and shall maintain all pumps, and have on-site sufficient fuel, hoses, pumps, and other miscellaneous equipment to provide uninterrupted pumping or dewatering as necessary.

The Contractor shall be responsible for maintaining all pumps in working condition and for maintaining a continuous pumping action to prevent flooding of the channel. The Contractor shall be responsible for all equipment left in the stream channel and for all damage that occurs due to flooding within the channel. All equipment shall be removed from the channel when not directly working in the channel. The Contractor shall also be responsible for

insuring that pumped or diverted waters contain a minimum of turbidity before their return to the creek.

All devices used for required dewatering in this Contract are considered temporary, and shall be removed by the Contractor at no additional expense to the Owner.

B. COFFERDAM SYSTEM

The cofferdam system shall be placed within areas shown on the Drawings. The Contractor shall exercise reasonable care when re-positioning the cofferdam system such that the release of any residual, turbid water from behind the enclosure is minimized. The cofferdam system shall not be positioned in a manner such that portions of it extend into the construction exclusion areas shown on the Drawings.

END OF SUBSECTION 545

SUBSECTION 548.00: DIVERSION SYSTEM

548.01 GENERAL

A. DESCRIPTION

The work included in this section includes all excavation, backfill, erosion and scour protection, and placement of flow control devices (headgates and culverts) necessary to effectively regulate flows in, and divert excess flows around, the reconstructed Silver Bow Creek channel. Principal elements of the diversion system include an earth and rock diversion structure with flow control devices and an overflow spillway, and a diversion channel which will convey diverted flows around the reconstructed channel. A county road crossing of the diversion channel, as well as temporary haul road crossings, will also be required.

B. RELATED WORK

Work in this Subsection shall be coordinated with work in the following, related Subsections:

Subsection 201 - Clearing and Grubbing
Subsection 202 - Excavation and Embankment
Subsection 545 - Incidental Dewatering and Cofferdams
Subsection 555 - County Road Culvert Crossing

C. SUBMITTALS

Submit the names of all material suppliers in addition to all data sheets and test results for confirmation of compliance testing to the Owner's Representative prior to delivery of aggregate materials to the site. All aggregate materials must be approved by the Owner's Representative prior to delivery to the site.

Quality assurance testing will be performed by the Owner's Representative to insure compliance with the Specifications and Drawings. Testing will be performed in accordance with applicable ASTM (American Society for Testing and Materials) test methods unless otherwise specified. If tests indicate materials do not meet specified requirements, the Contractor shall remove all soils or materials not meeting the specified requirements and replace the failing soils or materials with those meeting the Specifications. Removal and replacement of rejected soils shall be at the Contractor's expense. The frequency and need for testing shall be determined by the Owner's Representative.

Applicable ASTM test methodologies, procedures, and standards shall govern for all soil sampling, soil sample preparation, soil classification, field compaction and moisture content testing of soils, and laboratory density and moisture content testing of soils. Submit catalog data or brochures for manufactured items specified herein for use. Furnish certificates verifying that standards specified herein are met.

D. REGULATORY REQUIREMENTS

1. The Contractor shall comply with all Federal, State, and county water quality requirements and regulations.

2. The Contractor shall comply with all OSHA requirements and regulations including, but not necessarily limited to, electrical safety, trench safety, and excavation safety. All equipment and members of the Contractor's work force utilized on-site shall comply with all OSHA regulations.

548.02 MATERIALS

A. GENERAL

The materials used in the construction of the diversion channel and reconstructed channel shall conform to the requirements listed in the following Subsections.

Subsection 525 - Gabions
Subsection 535 - Stone
Subsection 610.02 - Storm Drain and Culverts (Materials)
Subsection 650.02(c) - Construction Fabric

B. DELIVERY/HANDLING/STORAGE

1. Stockpile materials at locations designated by the Owner's Representative. Stockpiles will not be allowed outside of project construction limits shown on the Drawings. Stockpile in sufficient quantities to meet project schedule and requirements. Stockpile differing materials with dividers or stockpile apart to prevent mixing. Direct surface water away from the stockpile to prevent erosion or product deterioration. Leave stockpile area in a clean and neat condition and grade site to its previous elevation at the conclusion of use. Excess stockpiled materials shall be removed from the project site; removal shall be solely the responsibility of the Contractor.

C. CORRUGATED STEEL PIPE (CSP) CULVERTS

CSP culverts shall adhere to material requirements in Subsection 610 - Storm Drain and Culverts, of these Specifications. The following materials and sizes shall be used:

1) Diversion Structure. Culverts shall be 30-inch diameter galvanized steel, with a wall thickness of 0.064 inch.

2) Temporary Haul Road Crossings. Culverts shall be 36-inch diameter galvanized steel, with a wall thickness of 0.064 inch.

D. HEADGATES

Headgates shall be Waterman C-10 Canal Gates or R-5 Steel Slide Gates. Frame height shall be a minimum of 6 feet. Headgates can be obtained from Roscoe Steel and Culvert Company, Missoula, MT, (406) 542-0345.

548.03 CONSTRUCTION REQUIREMENTS

A. PREPARATION

1. Construction Staking. Staking for the diversion system shall be completed by the Owner's Representative prior to commencement of the Work. Staking shall employ an offset layout for the diversion channel such that stakes can remain undisturbed during construction. Survey monuments used for horizontal and vertical control on the project shall be clearly delineated in the field.

B. CONSTRUCTION SEQUENCING

The following is a suggested sequence of construction activities for the diversion system. It is not required that the Contractor follow this sequence exactly; some activities may occur concurrently.

1. Begin diversion channel excavation proceeding from downstream to upstream. Construct levees as shown on the Drawings using excavated diversion channel material.
2. Construct new culvert beneath the county road for diversion channel.
3. Construct diversion channel haul road crossings.
4. Construct diversion channel outfall.
5. Place temporary diversion cofferdams.
6. Divert flow into diversion channel.
7. Construct diversion structure.
8. Remove temporary diversion cofferdams.

C. INSTALLATION

Diversion Channel Excavation. Excavation of the diversion channel and stockpiling of excavated materials shall be in accordance with Subsection 202 - Excavation and Embankment, of these Specifications. Excavated material shall be used to construct levees at locations shown on the Drawings. The areas necessary for construction of the diversion channel and levees shall be cleared and grubbed according to requirements in Subsection 201 - Clearing and Grubbing, of these Specifications. In areas where channel excavation intercepts groundwater, the Contractor shall provide all necessary equipment and labor to dewater the work area according to requirements set forth in Subsection 545 - Incidental Dewatering and Cofferdams, of these Specifications.

Incidental dewatering of the diversion channel shall only be required during the period of its construction, primarily to prevent the release of turbid waters into Silver Bow Creek. Silt-laden groundwater shall not be allowed to enter Silver Bow Creek. To prevent such discharges, a plug should be left at the downstream end of the diversion channel to permit removal of turbid water by pumping. As excavation proceeds upstream, additional plugs can be left in-place to accommodate dewatering. Dewatering of the diversion channel shall be terminated after creek flows have been diverted.

Diversion Channel Levee Construction. Levee construction includes placement and compaction of excavated diversion channel material to the lines and grades shown on the Drawings. Levees shall be constructed such that they form a continuation of the diversion channel sides and, therefore, care shall be taken to insure a smooth transition and consistent slope between the in-situ diversion channel side and the levee.

Levee fill material shall be placed in lifts with a maximum thickness of 12 inches and compacted to a minimum of 95% of the Standard Proctor Dry Density according to ASTM D698/AASHTO T99 - Moisture-Density Relations of Soils. Levee fill materials shall be placed within 3% of their optimum moisture content as determined by ASTM D2216 - Laboratory Determination of Moisture Content of Soil and Rock.

Diversion Channel Lining. A lining of stone material shall be placed on the diversion channel bottom and sides to the thickness, height, width and lines and grades shown on the Drawings, with a minimum of voids. The stone shall be manipulated sufficiently by means of suitable equipment to secure a reasonably regular surface and mass stability. Gradations for the stone material can be found in Subsection 535 - Stone, of these Specifications.

Diversion channel lining materials shall be placed according to the following schedule:

Diversion Channel Station Number	Material Type
D0-20 to D0+00	Type 2 Stone (on upstream face of diversion structure)
D0+00 to D26+22	Type 2 Stone
D26+92 to D27+57	Type 2 Stone (placed over gravel filter)
D27+57 to D54+88	Type 2 Stone
D54+88 to D55+88	Type 1 Stone
D55+88 to D56+12	1.5 ft. thick gabions filled with Type 2 Stone
D56+12 to D59+00	Type 1 Stone

The stone shall be placed to its full course thickness in one operation and in such a manner as to avoid displacing the underlying material. Placing of stone protection in layers or by dumping into chutes or by similar methods likely to cause segregation will not be permitted.

Diversion Channel Outfall. Erosion and scour protection shall be provided at the outlet of the diversion channel into the existing Silver Bow Creek channel. Protection shall consist of a gabion mattress grade control and a riprap stone apron placed to the thickness, and lines and grades shown on the Drawings. Bank stabilization fabric shall be placed beneath the gabions, as shown on the Drawings. Gabions, stone fill materials, and bank stabilization fabric used for outfall protection shall adhere to the requirements for these materials in Subsection 525 - Gabions, Subsection 535 - Stone, and Subsection 650.02(c) - Construction Fabric, of these Specifications.

Diversion Structure. Construction of the diversion structure shall consist of placement and compaction of excavated diversion channel material, to the lines and grades shown on the Drawings, across the existing Silver Bow Creek channel. The area necessary for construction of the diversion structure shall be cleared and grubbed according to requirements in Subsection 201 - Clearing and Grubbing, of these Specifications. Temporary diversion cofferdams shall be placed according to requirements in Subsection 545 - Incidental Dewatering and Cofferdams, of these Specifications. Diversion structure fill material shall be placed in lifts with a maximum thickness of 12 inches and compacted to a minimum of 95% of the Standard Proctor Dry Density according to ASTM D698/AASHTO T99 - Moisture-Density Relations of Soils. Materials shall be placed within 3% of their optimum moisture content as determined by ASTM D2216 - Laboratory Determination of Moisture Content of Soil and Rock. An overflow spillway shall be constructed through the top of the diversion structure, as shown on the Drawings, to allow flows in excess of the 10-year flow to spill back into Silver Bow Creek. The spillway shall be protected with gabion mattresses that meet the requirements set forth in Subsection 525 - Gabions, and Subsection 535 - Stone, of these Specifications.

Diversion Culverts. Two, 30-inch diameter, corrugated steel pipe (CSP) culverts shall be placed within the diversion structure, as shown on the Drawings, for the purpose of conveying flows up to 50 cubic feet per second (cfs) into the reconstructed channel. Headgates shall be placed at the upstream end of the culverts for the purpose of controlling flows in the reconstructed channel. The culverts shall meet the material requirements set forth in Subsection 610 - Storm Drain and Culverts, of these Specifications.

Bedding for the culverts shall consist of a layer of granular fill material placed beneath the culverts to the thickness shown on the Drawings. The granular fill shall meet the gradation requirements provided in Subsection 535 - Stone, of these Specifications. Granular fill material shall also be placed beneath the haunches and up to the mid-line of the culverts, as shown on the Drawings, and compacted to a minimum of 95% of the Standard Proctor Dry Density (SPDD) according to ASTM D698/AASHTO T99. Granular fill material shall be placed on both sides of the culvert barrels simultaneously so that fill height is maintained at a constant level across the cross-section. General backfill material shall be placed in lifts with a maximum thickness of 6-inches along the upper sides of the culverts and to a minimum height of 12-inches over the culverts and compacted to 95% SPDD.

County Road Culvert Crossing. The diversion channel alignment intersects a county road between Stations D26+22 and D26+92. Refer to the Drawings and Subsection 555 - County Road Culvert Crossing, of these Specifications for detailed design information.

Temporary Haul Road Crossings. Temporary crossings of the diversion channel will be required to provide access for removal of tailings/impacted soils from the floodplain. Proposed locations for the crossings shall be submitted by the Contractor to the Owner's Representative for approval.

Crossings shall consist of a road prism constructed around and over two (2) 36-inch CSP culverts, which are designed to convey flows up to 70 cfs in the diversion channel without exceeding the top elevation of the culverts. At a flow of approximately 100 cfs the crossings will begin to overtop, which could result in damage to, or complete washout of, the crossing. Any required repair or reconstruction of the crossings shall be at the Contractor's expense. The culverts shall meet the material requirements set forth in Subsection 610 - Storm Drain and Culverts, of these Specifications. Construction of the crossings, including culvert placement, shall be in accordance with the Drawings and shall adhere to the following specifications.

Bedding for the culverts shall consist of a layer of granular fill material placed beneath the culverts to the thickness shown on the Drawings. The granular fill shall meet the gradation requirements provided in Subsection 535 - Stone, of these Specifications. Granular fill material shall also be placed beneath the haunches and up to the mid-line of the culverts, as shown on the Drawings, and compacted to a minimum of 95% of the Standard Proctor Dry Density (SPDD) according to ASTM D698/AASHTO T99. Granular fill material shall be placed on both sides of the culvert barrels simultaneously so that fill height is maintained at a constant level across the cross-section. General backfill material shall be placed in lifts with a maximum thickness of 6-inches along the upper sides of the culverts and to a minimum height of 12-inches over the culverts and compacted to 95% SPDD.

The road surface shall consist of an 12-inch layer of granular fill material that meets the gradation requirements as specified in Subsection 535 - Stone, of these Specifications. The granular fill material shall be compacted to a minimum of 95% SPDD.

END OF SUBSECTION 548

SUBSECTION 550.00: TRAFFIC CONTROL

550.01 GENERAL

A. DESCRIPTION - Traffic control shall consist of furnishing, installing, maintaining, and relocating necessary traffic signs, barricades, lights, signals, pavement markings, and other traffic control devices necessary to insure the safety of the general public and project personnel. This work shall include flagging for the guidance of traffic through the work zone and the furnishing and application of water for dust control.

B. OPERATIONS - The Contractor shall at all times conduct his operations so that there is a minimum interruption in the use of the roads and highways involved.

The Contractor shall schedule his operations to keep all roads and streets open to a minimum of one-way traffic during normal working hours during construction. Two-way traffic shall be provided at all times during overnight and weekend periods.

All work shall be done in accordance with the Contract Documents, the Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD) as published by the U.S. Department of Transportation, the Montana Department of Highways (MDOH) Standard Specifications for Road and Bridge Construction, the Special Provisions, the approved traffic control plan, and as required by the Engineer.

C. SUBMITTALS

1. Traffic Control Plan. The Contractor shall submit a traffic control plan for any work involving public roadways. All traffic control plans shall be submitted and accepted prior to construction and shall meet the requirements specified herein. The traffic control plan shall include the following as appropriate:

   - Itemization of signing, including: type, size, shape, color, location, and MUTCD reference.
   - Temporary pavement markings.
   - Channelization (cones, barrels, barricades, etc.).
   - Flagging, including: personnel numbers, time on location, location.
   - Lighting.
   - Road closures and time of road closure.
   - Special traffic patterns (pilot cars, one-way traffic lanes, detours).
   - Signing during non-work hours.

   The traffic plan will be subject to review and approval by the Montana Department of Highways for roads under their jurisdiction, by the appropriate county for roads under county jurisdiction, and by any other public entity having jurisdiction over other public roadways (U.S. Forest Service, city, etc.). These approvals will be in addition to that provided by the Engineer in accordance with the Submittals Section. No work may commence until all approvals of the traffic plan have been secured.

550.02 MATERIALS

All traffic control device materials shall be in accordance with MDOH Standard Specifications for Road and Bridge Construction, most current edition.

550.03 CONSTRUCTION REQUIREMENTS

All devices utilized for traffic control shall be in accordance with the requirements of the Manual on Uniform Traffic Control Devices (MUTCD) for Streets and Highways, most current edition.

Before placement of any traffic control for any stage of construction, the Contractor shall have on hand at the project site all traffic control devices required for that construction stage. All traffic control devices necessary for construction shall be properly placed and in operation and approved before any construction is allowed to start. All devices shall be constructed and erected in a workmanlike manner and shall be properly maintained, cleaned, and operated during the entire time they are used. They shall remain in place only as long as they are needed and shall be removed immediately thereafter. Where operations are performed in stages, there shall be in place only those signs that apply to the present stage of construction. Signs that do not apply to the existing conditions shall be covered with opaque material, turned, or removed, so as not to be readable to oncoming traffic.

Construction equipment, vehicles, materials, and debris shall be stored or parked a minimum of 30 feet from the edge of the travelled way or behind guardrail. When it is not feasible to park equipment or store materials a minimum of 30 feet from the edge of the travelled way or behind guardrail, adequate warning devices and protective measures shall be utilized.

All traffic control devices furnished by the Contractor shall remain the property of the Contractor and shall be removed from the project when their use is no longer required. All properly installed traffic control devices shall be replaced by the Contractor when destroyed by traffic.

The Contractor shall schedule his construction operations in a manner which will assure that: 1) the safety and convenience of motorists and pedestrians, and the safety of construction workers, are adequately met at all times; and 2) the project is completed in a manner most beneficial to the project as a whole. Traffic control shall be provided in full compliance with MUTCD during materials hauling and equipment operation or transport along public roadways. No separate payment will be made for traffic control and all costs for traffic control shall be absorbed in other work items included in the Contract bid.

SUBSECTION 555.00: COUNTY ROAD CULVERT CROSSING

555.01 GENERAL

A. DESCRIPTION

Work included in this Subsection shall consist of supplying all necessary equipment, materials, and labor required to construct two culvert crossings at locations where the reconstructed channel and diversion channel intersect an existing county road, as shown on the Drawings. Work items shall include all excavation, backfilling, embankment placement, compaction, culvert placement, and grading required to re-construct the county road at the crossing locations.

B. RELATED WORK

Work in this Subsection shall be coordinated with work in the following, related Subsections:

Subsection 202 - Excavation and Embankment
Subsection 205 - Reconstructed Channel
Subsection 545 - Incidental Dewatering and Cofferdams
Subsection 548 - Diversion System

C. SUBMITTALS

Submit the names of all material suppliers in addition to all data sheets and test results for confirmation of compliance testing to the Owner's Representative prior to delivery of aggregate, concrete and geotextile materials to the site. All materials must be approved by the Owner's Representative prior to delivery to the site.

Quality assurance testing will be performed by the Contractor to insure compliance with the Specifications and Drawings. Testing will be performed in accordance with applicable AASHTO (American Association of State Highway and Transportation Officials) test methods unless otherwise specified. If tests indicate materials do not meet specified requirements, the Contractor shall remove all materials not meeting the specified requirements and replace the failing materials with those meeting the Specifications. Removal and replacement of rejected materials shall be at the Contractor's expense. The frequency and need for testing shall be determined by the Owner's Representative.

Results of the following tests shall be submitted to the Owner's Representative:

- Moisture-density characteristics using AASHTO T-180 for roadway embankments, subgrade, and base/surface course materials. As material types change during construction, additional moisture density tests may be required by the Owner's Representative.

- Fill imported from off-site sources shall be tested and submitted, including source location, sieve analysis (AASHTO T-11 & T-27), liquid limits & plastic limits (AASHTO T-89 and T-90), and moisture-density relationships (AASHTO T-180).

- All base/surface course material shall be tested and submitted, including source location, sieve analysis (AASHTO T-11 & T-27), moisture-density relationships (AASHTO T-180), liquid limit & plastic limits (AASHTO T-89 and T-90), and California Bearing Ratio (CBR)(AASHTO T-193) testing.

- In-place field density testing shall be performed and results submitted. One in-place field density test is required for every 100 cubic yards of roadway base course and surface course material placed. The compacted base course and surface course must be 95% of standard proctor dry density (SPDD) as determined by AASHTO T-180. The field density testing will be performed in accordance with AASHTO T-238 and T-239.

D. REGULATORY REQUIREMENTS

1. The Contractor shall comply with all Federal, State, and county water quality requirements and regulations.

2. The Contractor shall comply with all OSHA requirements and regulations including, but not necessarily limited to, electrical safety, trench safety, and excavation safety. All equipment and members of the Contractor's work force utilized on-site shall comply with all OSHA regulations.

555.02 MATERIALS

A. GENERAL

The materials used in the construction of the road prism and culvert crossings shall conform to the requirements listed in the following Subsections.

Subsection 535 - Stone
Subsection 610.02 - Storm Drain and Culverts (Materials)
Subsection 710 - Structural Concrete
Subsection 810 - Aggregate Base Course
Subsection 820 - Crushed Top Surfacing Course

B. DELIVERY/HANDLING/STORAGE

1. Stockpile materials at locations designated by the Owner's Representative. Stockpiles will not be allowed outside of project construction limits shown on the Drawings. Stockpile in sufficient quantities to meet project schedule and requirements. Stockpile differing materials with dividers or stockpile apart to prevent mixing. Direct surface water away from the stockpile to prevent erosion or product deterioration. Leave stockpile area in a clean and neat condition and grade site to its previous elevation at the conclusion of use. Excess stockpiled materials shall be removed from the project site; removal shall be solely the responsibility of the Contractor.

2. Materials damaged during transport, storage or placement shall be replaced at the Contractor's expense.

C. ROADWAY BASE COURSE MATERIAL

Base course material for the reconstructed county road shall meet the requirements and gradations for Grade 1 - Base Course Material as specified in Subsection 810 - Aggregate Base Course, of these Specifications. The gradation requirements are also shown in Subsection 535 - Stone, of these Specifications.

D. ROADWAY SURFACE COURSE MATERIAL

Material for the reconstructed county road surface shall meet the requirements and gradations for Grade 1 - Crushed Surfacing Material as specified in Subsection 820 - Crushed Top Surfacing Course, of these Specifications. The gradation requirements are also shown in Subsection 535 - Stone, of these Specifications.

E. EMBANKMENT MATERIAL

General backfill material excavated from on-site may be used for embankment material below the roadway base course material and above the culverts.

F. CULVERT BEDDING MATERIAL

Bedding material for culvert placement shall meet the gradation requirements of granular fill as shown in Subsection 535 - Stone, of these Specifications.

G. CULVERTS

Culverts shall meet the material requirements of Subsection 610.02(2.c.) - Storm Drains and Culverts, of these Specifications. The culvert size and type for both crossings (reconstructed channel and diversion channel) shall be an 11'-10" x 7'-7", galvanized steel pipe arch culvert. Corrugations shall be 6" x 2", and minimum wall thickness shall be 0.109".

H. CONCRETE HEADWALL PROTECTION

Structural concrete to be used for culvert headwall protection shall conform to requirements in Subsection 710 - Structural Concrete, of these Specifications. The classification of the concrete shall be C-4000, per Subsection 710. Reinforcing steel shall conform to requirements in Subsection 710.02(j).

I. CULVERT CUTOFF WALL

A structural concrete cutoff wall shall be placed beneath the entrance to the culverts as shown on the Drawings. The classification of the concrete shall be C-3000, per Subsection 710 - Structural Concrete, of these Specifications.

J. RIPRAP EMBANKMENT PROTECTION

Riprap material to be placed over the earthen embankment material and above the concrete headwall protection, as shown on the Drawings, shall be Type 2 Stone and shall meet the gradation and material requirements in Subsection 535 - Stone, of these Specifications.

555.03 CONSTRUCTION REQUIREMENTS

A. PREPARATION

1. Construction Staking. Staking for the county road crossing shall be completed by the Owner's Representative prior to commencement of the work. Staking shall employ an offset layout for the channel such that stakes can remain undisturbed during construction. Survey monuments used for horizontal and vertical control on the project shall be clearly delineated in the field.

B. CULVERT INSTALLATION

Site Preparation. All areas scheduled for excavation and embankment construction shall be cleared and grubbed in accordance with Subsection 201 - Clearing and Grubbing, of these Specifications. Remove and dispose of any tailings/impacted soils that may be present in the areas to be affected by the road crossing construction.

Bedding Preparation. Bedding for the culverts shall consist of a layer of granular fill material placed beneath the culverts to the lines, grades, and thickness shown on the Drawings. Granular fill material shall also be placed beneath the haunches of the culverts, as shown on the Drawings, and compacted to a minimum of 95% of the Standard Proctor Dry Density (SPDD) according to ASTM D698/AASHTO T99. Granular fill material shall be placed on both sides of the culvert barrels simultaneously so that fill height is maintained at a constant level across the cross-section.

Culvert Placement. Culverts shall be placed to the lines and grades shown on the Drawings, and in accordance with manufacturer's recommendations.

Placement of Headwall Protection. Culvert headwall and embankment protection materials shall be placed as shown on the Drawings. The culverts shall be anchored to the structural concrete headwalls as detailed on the Drawings (Sheet I26). Structural concrete and steel reinforcement shall be cast and placed in accordance with Subsection 710 - Structural Concrete, of these Specifications.

C. EMBANKMENT AND ROADWAY CONSTRUCTION

Embankment Construction. General backfill material shall be placed in lifts with a maximum thickness of 6-inches along the upper sides of the culverts and to a minimum height of 12-inches over the culverts and compacted to 95% SPDD.

Roadway Construction. The roadway shall consist of base course and surface course layers. The base/surface course layers shall be placed to the lines and grades shown on the Drawings in maximum 6" lifts and compacted to 95% SPDD.

END OF SUBSECTION 555

SECTION 600: PIPED UTILITIES AND DRAINAGE SYSTEM

SUBSECTION 610.00: STORM DRAIN AND CULVERTS

610.01 GENERAL

A. DESCRIPTION - This section covers drainage culverts and storm drains, constructed of corrugated metal, reinforced concrete, and plastic pipe, along with manholes, inlets, and other appurtenances. Pipe material classifications, inlet and manhole types, and coatings or linings shall be as shown on the Drawings and/or listed in the Proposal.

B. SUBMITTALS - The following submittals are required in accordance with the Supplementary Conditions:

- Manufacturers' catalog cuts and product specifications for pipe and fittings.
- Certification by the manufacturer of the pipe to be furnished on this project, certifying that the pipe complies with the applicable specifications.
- Layout drawings for manholes, inlets, and structures indicating dimensions and inlet/outlet connections.
- Concrete mix design and strength for precast and cast-in-place concrete.
- Manufacturers' catalog cuts, dimensional data, materials, and product specifications for manhole steps, rings and covers, grates, joint sealant, and appurtenances.
- Manufacturers' installation manuals for pipe and fittings.

C. REFERENCE STANDARDS - All pipe, fittings, manholes, precast concrete structures, and appurtenance shall be manufactured and installed in accordance with all applicable requirements of the most current editions of ASTM, ANSI, and AASHTO.

D. PIPE MARKINGS - All pipe shall be clearly and permanently marked by the manufacturer with type, class, and/or thickness as applicable. Lettering shall be legible at the time of installation.

610.02 MATERIALS

A. CORRUGATED STEEL PIPE AND PIPE ARCHES

1. Pipe and Joints. Corrugated steel pipe and pipe arches and coupling bands shall meet the requirements of AASHTO M 36 except as modified as follows:

   Bands with projections (dimple bands) will be allowed only to join dissimilar ends of pipe and shall be approved by the Engineer.

   Pipe with helical corrugations shall be rerolled at the ends to form a minimum of 2 annular corrugations to accommodate the use of annular corrugated locking bands.

   Minimum band width shall be 10 1/2 inches for "hugger" type bands and 12 inches for annular type bands.

   Lock seam helically corrugated pipe to be used for drain pipe installations shall have the lock seams at the pipe ends welded prior to rerolling to prevent unraveling of the seams.

   Pipe with helical corrugations shall have a continuous seam extending from end-to-end of each length of pipe section. Helical seams shall be fabricated in a manner that they will develop the full strength of the pipe and not affect shape or nominal diameter of the

pipe. Folded lock seams or ultra-high-frequency resistance butt-welded seams shall be used. Any damage to the spelter coating shall be cleaned and painted as specified in AASHTO M 35.

When specified "WATERTIGHT", the following additional requirements shall apply:

a. The pipe supplied may be annular corrugated pipe, lock seam helically corrugated pipe, or welded seam helically corrugated pipe. Annular corrugated pipe shall be close-riveted and soldered or close-riveted and welded. Lock seam helically corrugated pipe shall have the lock seams welded continuous from end-to-end of each pipe section. The welding shall be accomplished prior to rerolling of the ends. All fabrication shall be in accordance with AASHTO M 36.

b. Field joints shall be constructed to provide watertight connections. The basic connection shall be a minimum 12 inches wide "rod and lug" type band or a 10 1/2 inches wide "hugger" type band. Joints constructed with "rod and lug" type bands shall be gasketed with a minimum 3/8 inch thick by 12 inches wide neoprene gasket. "Hugger" type bands shall be provided with O-ring gaskets. If required, gaskets and/or coupling bands or devices shall require prior approval of the Engineer.

c. When required, the fabricator shall conduct watertightness tests, in the presence of the Engineer if specified, on the type or types of pipe and coupling devices to be supplied. The test method or procedure shall be submitted to the Engineer for approval prior to any testing. The Engineer may require the fabricator to conduct the tests using a test method or procedure specified by the Engineer.

2. Corrugated Pipe - Coatings. When specified, the following conduits shall meet all the requirements for Corrugated Steel Pipe, as well as the following:

a. Bituminous Coated Corrugated Steel Pipe and Pipe Arches. These conduits and the coupling bands shall meet the requirements of AASHTO M-190 for the specified sectional dimensions, thickness, and type of bituminous coating.

Type A - Fully Bituminous Coated
Type B - Half Bituminous Coated with Paved Invert
Type C - Fully Bituminous Coated with Paved Invert
Type D - Fully Bituminous Coated and 100% Paved or Lined Interior

Special sections such as elbows and prefabricated flared end sections shall be fully coated with bituminous material.

b. Type II Aluminized Corrugated Steel Pipe and Pipe Arches. These conduits and coupling bands shall meet the requirements of AASHTO M-274.

c. Precoated, Galvanized Corrugated Steel Pipe and Pipe Arches. These conduits and coupling bands shall meet the requirements of AASHTO M-245 and M-246. Coating shall be 0.010 inch (0.25 mm) minimum on both inside and outside surfaces and shall meet the requirements of AASHTO M-246, Section 7.

d. Asbestos-Bonded, Bituminous Coated Corrugated Steel Pipe and Pipe Arches. These conduits and coupling bands shall meet the requirements of Federal Specification WW-P-405B. Bituminous coating shall comply with "a" above.

3. Corrugated Aluminum Pipe and Pipe Arch. These conduits and coupling bands shall meet the requirements of AASHTO M-196.

B. POLYVINYL CHLORIDE (PVC) PIPE - PVC pipe used for storm drains or culverts shall meet the material requirements of Subsection 620.00, Sanitary Sewer Mains and Service Connections.

C. CORRUGATED POLYETHYLENE PIPE - Corrugated polyethylene pipe and fitting shall meet the requirements of AASHTO M252 and M294 and ASTM F667. The pipe and fittings shall be Advanced Drainage System 1201 or equal. Where called for on the Drawings, corrugated polyethylene pipe shall be perforated (slotted) with the manufacturer's standard perforation; field perforating will not be allowed. Pipe shall be furnished in continuous coils of the manufacturer's standard length with joints and/or couplings as recommended by the manufacturer. Fittings shall likewise be of the manufacturer's recommended type for the pipe and shall be constructed of like material to the pipe.

D. REINFORCED CONCRETE PIPE - Reinforced concrete pipe shall meet the requirements of ASTM C76, and shall be Class 3 unless otherwise noted on the Drawings. Pipe joints shall be either gasketed or ungasketed as noted on the Drawings and/or listed on the Proposal. Pipe joints for ungasketed applications shall be of the tongue-and-groove design and for gasketed pipe shall be either modified tongue-and-groove or bell- and-spigot. Gasketed pipe shall use a round rubber gasket meeting ASTM C361, and the joint system shall meet ASTM C443. Ungasketed pipe shall likewise be equal to that manufactured by Elk River Concrete. Pipe laying lengths shall be the manufacturer's standard, modified as necessary to meet specific project installation requirements.

Cement for use in manufacturing of concrete pipe shall be Type IIA Modified, Type V, or any other approved cement which contains less than 5% Tricalcium Aluminate. Strength classifications for C14 and/or C76 specification pipe shall be as listed in the Proposal, Special Provisions, and/or Drawings.

The maximum absorption allowed shall be 7% rather than 8% as stated in the ASTM specification. For pipe sizes smaller than 12 inches in diameter, the proportion of Portland cement in the concrete mixture shall not be less than 6.5 U.S. standard (94 pounds) bags per cubic yard of concrete, and the water cement ratio shall not exceed 6 gallons per sack of cement.

Each pipe shall be marked with gage marks to indicate that the joint has closed properly to a uniform and minimum allowable gap.

E. MANHOLES AND INLETS

1. General. The type of manhole, channel, and inlet shall be as specified and indicated on the Drawings and Standard Drawings. Manholes shall be constructed according to the material requirements in Subsection 620.00, Sanitary Sewer Mains and Service Connections.

2. Inlet Frames and Grates. Cast iron, model as noted on the Drawings.

610.03 CONSTRUCTION REQUIREMENTS

A. EXCAVATION AND BACKFILL - Excavation and backfill for pipelines shall conform to the applicable portions of Subsection 210.00, Trench Excavation and Backfill.

B. RESPONSIBILITY FOR MATERIAL - The Contractor shall be responsible for all material furnished by him and shall replace at his own expense all such material found defective in manufacture or damaged in handling or storage after delivery by the manufacturer. This shall include furnishing all material and labor required for the replacement of installed material discovered defective prior to final acceptance of the work or during the guarantee period.

C. HANDLING OF PIPE - Pipe, fittings and accessories shall be loaded and unloaded by lifting with hoists or skidding so as to avoid shock or damage. Under no circumstances shall materials be dropped. Pipe handled on skidways shall not be skidded or rolled against pipe already on the ground. In distributing the material at the site of the work, each piece shall be unloaded opposite or near the place where it is to be laid in the trench.

Pipe shall be handled so that no coating or lining will be damaged. If, however, any part of the coating or lining is damaged, the pipe shall be replaced or a repair shall be made by the Contractor at his expense in a manner satisfactory to the Engineer.

D. LAYING PIPE - All pipe shall be laid and maintained to the required lines and grades with fittings, tees and manholes at the required locations. Pipe installation shall be in accordance with the manufacturer's recommendations.

Every precaution shall be taken to prevent foreign material from entering the pipe while it is being installed. The Contractor shall clean and remove all sand, gravel, concrete and cement grout that has entered the lines in the process of construction.

E. TOLERANCES - The storm drains and culverts shall be installed within 1/4 inch for grade and shall not be off more than 1/2 inch for alignment.

F. MANHOLES - Manholes shall be constructed according to the Construction Requirements of Subsection 620, Sanitary Sewer Mains and Service Connections, and Standard Drawings of that section. Inlet structures shall be as shown on the Drawings.

G. TESTS

1. Light Test. After the trench has been backfilled a light test shall be made between the ends of the culverts to check alignment and grade for displacement of pipe. Except for curved alignments shown on the Drawings, the completed pipeline shall be such that a true circle of light can be seen from one end of the culvert to the other end or between adjacent manholes. If alignment or grade is other than specified and displacement of pipe is found, the Contractor shall remedy such defects at his own expense.

2. Leakage Test. Unless specified in the Special Provisions, a leakage test will not be required. However, this does not preclude the fact that obvious and concentrated leaks (such as open joints, pinched gaskets, cracked barrels or bells, etc.) will not be allowed.

SUBSECTION 650.00: CONSTRUCTION FABRIC

650.01 GENERAL

A. DESCRIPTION - This section covers installation of construction fabrics for drainage, silt control or embankment stabilization. Material classifications, location and installation shall be shown on the Drawings and/or listed in the Proposal.

B. SUBMITTALS - The following submittals are required in accordance with the Supplementary Conditions:

- Manufacturers' catalog cuts, material, and product specifications for construction fabric.
- Certification by the manufacturer of the fabric to be furnished on this project, certifying that the fabric complies with the applicable specifications.
- Certified test results for permeability, tensile and burst strength for fabric material.
- Certified test results for UV resistance of fabric material.
- Manufacturer's installation instructions for seaming and installing fabric.

C. REFERENCE STANDARDS - All fabric shall be manufactured and installed in accordance with all applicable requirements of the most current editions of ASTM, ANSI, and AASHTO.

650.02 MATERIALS

A. GENERAL - Construction fabrics shall be of the type noted on the Proposal or described on the Drawings or in the Special Provisions. Fabric type will be identified based on appropriateness for the application.

B. DRAINAGE FABRIC - Drainage fabric shall be non-directional (non-woven) designed to allow water passage while retaining soil particles, allowing a water flow rate of at least 250 gpm/sf (clean fabric condition). Thickness shall be at least 50 mils with a minimum weight of 4 oz/sy. Fabric shall be constructed of spun or matted fibers or random orientation. Equivalent U.S. Standard Sieve opening size shall be no greater than 200 per test method COE CW 02215-77. Grab strength per ASTM D-1682-64 shall be at least 100 lb. Drainage fabric shall be equal to Mirafi 140N.

C. BANK STABILIZATION FABRIC - Bank stabilization fabric shall be woven (directional), and designed to provide a filter medium beneath riprap or on slopes to prevent erosion. Thickness shall be at least 16 mils, with a grab strength per ASTM D-1682-64 of at least 300 lb. in each direction. Water flow rate shall be at least 100 gpm/sf. Mullen burst strength (ASTM D-3786-80) shall be a minimum of 500 psi, and puncture strength per ASTM D-3787-80 shall be at least 135 lb. UV radiation stability shall be at least 85% as determined by ASTM G-26/D-1682-64. Bank stabilization fabric shall be equal to Mirafi 700X.

D. GRADE STABILIZATION FABRIC - Grade stabilization fabric shall be woven (directional), and designed to stabilize subgrades for roadways or prevent migration of fines into aggregate courses. Thickness shall be at least 20 mils, with a grab strength per ASTM D-1682-64 of at least 200 lb. Water flow rate shall be at least 30 gpm/sf. Mullen burst strength (ASTM D-3786-80) shall be a minimum of 350 psi, and puncture strength per ASTM D-3787-80 shall be at least 80 lb. UV radiation stability shall be at least 30% as determined by ASTM G-26/D-1682-64. Grade stabilization fabric shall be equal to Mirafi 500X.

E. SILT FENCE - Silt fence shall be a woven (directional) fabric designed for retention of silt in runoff, backed by an industrial netting stitched to the fabric. Fabric shall be furnished in 100 feet continuous rolls of at least 3-foot width. Net backing may be 6 inches less than fabric width. Silt fence shall be suitable for attachment to driven wood or steel posts. Silt fence shall be equal to Mirafi Enviro-Fence 100X.

650.03 CONSTRUCTION REQUIREMENTS

A. CONSTRUCTION FABRICS - Construction fabrics shall be installed on prepared subgrade surfaces or otherwise installed as shown on the Drawings. The surface receiving the fabric shall be free of excessive irregularities and sharp or pointed rocks or debris that may puncture or tear the fabric. If necessary a sand or soil cushioning course of 2 inches thickness shall be used beneath the fabric at no additional cost to the Owner.

Fabric shall be continuous for the entire width of area shown on the Drawings. End joints shall be lapped at least 3 feet. Fabric shall be folded to form the radius around bends. All tears, holes and other imperfections shall be covered with a patch extending no less than 3' feet in each direction from the imperfection.

B. SILT FENCE - Silt fence shall be erected by attachment to driven wood or metal posts or other suitable anchors at a maximum spacing of 10 feet. Fence shall be erected to prevent sags that runoff water may overtop. If necessary to prevent sagging, silt fence shall be backed with metal mesh. Joints in silt fence shall be lapped a minimum of 5 feet, and secured against breaching.

SECTION 700: STRUCTURES

SUBSECTION 710.00: STRUCTURAL CONCRETE

0.01 GENERAL

A. DESCRIPTIONS - This work shall consist of constructing cast-in-place concrete structures, and concrete portions of composite structures, in accordance with these and other specifications and to the lines, grades, and dimensions shown on the Drawings or as ordered in writing by the Engineer.

B. RELATED WORK - The Contractor shall carefully coordinate the concrete work with all other work associated therewith. No concrete shall be placed until all other work to be enclosed or covered by the concrete has been installed, tested, inspected and approved as applicable. Other work includes, but is not limited to piping, and other utilities to be placed in or under concrete work, anchor bolts, inserts, door hardware and other miscellaneous items to be incorporated on or within the finished concrete work.

C. SUBMITTALS - The following submittals shall be required in accordance with the Supplementary Conditions:

- Name and location of ready mix supplier(s) and aggregate sources;
- Detailed schedule of concrete work indicating dates for forming, completing reinforcing installation and pouring for each item of work;
- Anticipated areas of construction joints;
- Concrete mix design for each type of concrete specified;
- Manufacturer's specifications for concrete additives, curing agents, and hardeners; and
- Reinforcing steel shop drawings and schedules, including splice locations.

The report for each tentative concrete mix submitted shall contain the following information:

1. Slump on which design is based;
2. Total gallons of water per cubic yard;
3. Brand, type, composition, and quantity of cement;
4. Specific gravity, moisture content, and gradation of each aggregate;
5. Deleterious substances, soundness, and percent wear for each aggregate, plus organic impurities for fine aggregates;
6. Weight (surface dry) of each aggregate per cubic yard;
7. Brand, type, ASTM designation, active chemical ingredients, and quantity of each admixture;
8. Air contents;
9. Compressive strength based on 7-day and 28-day compression tests; and
10. Time of initial set.

D. AIR-ENTRAINED CONCRETE - Air-entrained concrete shall be used in all applications. Concrete shall contain an air-entraining agent. An air-entraining Portland Cement shall not be used.

E. CLASSIFICATION - Concrete is classified as set forth below. Each class of concrete shall be used in that part of the structure in which it is called for in the Drawings, or where specified. Concrete with prefixes "C" will contain 1 1/2 inches size aggregate and those with "M" will contain 3/4 inch size aggregate. Concrete with prefixes "M" may be substituted for concrete with prefixes "C".

Each class of concrete shall be used in that part of the structure in which it is called for on the Drawings or specified below.

C-3000	Concrete Collars, Thrust Blocks and Miscellaneous Concrete Construction
M-4000*	Reinforced Concrete Inlet and Outlet Structures and or Retaining Walls

C-3000 designated concrete with 1 1/2 inches maximum aggregate, and a 28-day strength of 3000 psi.

M-4000 designated concrete with 3/4 inch maximum aggregate, and a 28-day strength of 4000 psi.

*C-4000 may be used if the narrowest dimension between forms is greater than 7 1/2 inches or if the slab thickness is greater than 4 1/2 inches.

710.02 MATERIALS

A. COMPOSITION OF CONCRETE -

1. Design. All concrete mix design shall utilize a minimum of 5.5 sacks of Portland cement per cubic yard. For concrete of normal weight, mixture proportions to provide the desired characteristics shall be developed using one of the following described methods:

   a. Method One. The design volume of coarse aggregate, fine aggregate, and the minimum allowable cement measured into each batch shall be in accordance with a laboratory mix design prepared by an approved independent testing laboratory.

   The laboratory mix design, specifying the minimum cement content, the quantity of fine and coarse aggregate, and the maximum quantity of mixing water will be designed in accordance with Table I in the following Section B.

   The laboratory mix design, prepared by an independent testing laboratory, shall be furnished and paid for by the Contractor and approved by the Engineer.

   b. Method Two. In lieu of laboratory mix design to establish required average strength level, as described for Method One, appropriate field test data for concrete made with similar ingredients may be used. Use of the proposed mixture proportions shall be subject to approval by the Engineer based on their

demonstrated ability to produce concrete meeting all requirements of the Specifications. Ability to produce the required average strength calculated in accordance with the following paragraphs shall be determined on the basis of the strength test record of 30 or more tests made during the past year which will permit establishing, directly or by interpolation, the water-cement ratio corresponding to the required average strength.

1. Required Average Strength. Where the production facility has a control record, based on at least 30 consecutive strength tests of a similar mix or mixes obtained within the past year representing similar materials and conditions to those expected, the average strength used as the basis for selecting proportions shall exceed the specified strength f_c' by at least:

   400 psi if the standard deviation* is less than 300 psi
   500 psi if the standard deviation is 300 to 400 psi
   700 psi if the standard deviation is 400 to 500 psi
   900 psi if the standard deviation if 500 to 600 psi

   * For definition and method of calculating standard deviation, see "Recommended Practice for Evaluation of Compression Test Results of Field Concrete" (ACI 214).

   If the standard deviation exceeds 600 psi or if a suitable record of strength test performance is not available, proportions shall be selected to produce an average strength at least 1200 psi greater than the specified strength f_c'.

   The strength test history used to determine standard deviation will be considered to comply with the above requirement for 30 consecutive strength tests if the tests represent either a group of 30 consecutive batches of the same class of concrete or the statistical average for 2 groups totaling 30 or more batches. The tests used in establishing the standard deviation shall represent concrete produced for a specified strength or strengths within 1000 psi of that required for the proposed work; changes in materials and proportions within the population of background tests shall not have been more closely restricted than will be the case for the proposed work.

2. Mix Requirements. Concrete shall be mixed in conformance with ASTM Standard C 94 and in accordance with the approved mix report. Class shall be as scheduled and as defined below:

Class	Definition
C-3000	designates concrete with 1 1/2 inches maximum aggregate, (ASTM C 33 size number 467 coarse aggregate) 5% air entrainment, 7-day strength of 1800 psi, and a 28-day strength of 3000 psi.
C-4000	designates concrete with 1 1/2 inches maximum aggregate, (ASTM C 33 size number 467 coarse aggregate) 5% air entrainment, 7-day strength of 2400 psi, 28-day strength of 4000 psi.

M-3000 designates concrete with 3/4 inch maximum aggregate (ASTM C 33 size number 67 coarse aggregate), 6% air entrainment, 7-day strength of 1800 psi, 28-day strength of 3000 psi.

M-4000 designates concrete with 3/4 inch maximum aggregate, (ASTM C 33 size number 67 coarse aggregate), 6% air entrainment, 7-day strength of 2400 psi, 28-day strength of 4000 psi.

In areas where the concrete is protected and not exposed to freeze-thaw cycles or deicing chemical, the maximum air entrainment may be reduced from 5% to 3 1/2% for Class C-3000 and C-4000 concrete and from 6% to 5% for Class M-3000 and M-4000 concrete.

Slump of the concrete shall be a minimum of 1 inch and a maximum of 4 inches.

B. CEMENT - Portland Cement shall conform to the requirements of AASHTO M-85 or ASTM C-150, Type II. Where specified, sulfate-resistant Type V cement shall be used.

Only one brand of cement shall be used on the Contract except by written permission from the Engineer. If more than one brand is permitted by the Engineer, they shall not be used alternately in any one pour. The Contractor shall provide suitable means for storing cement and protecting it from dampness.

C. AIR-ENTRAINING AGENTS - An air-entraining agent shall be added to the concrete mixture. The air-entraining agent being used shall not be changed without permission of the Engineer.

Before any air-entraining agent can be used, evidence based on tests made in a recognized laboratory shall be submitted to show that the material conforms to the requirements of the latest revision of AASHTO M-154 (ASTM C-260).

D. ADMIXTURES - An admixture may be used if advance permission is obtained from the Engineer. No admixture shall be considered for approval which cannot show either certified laboratory test results or satisfactory field performance records to substantiate any and all claims made for the product. Admixtures shall meet the requirements of ASTM C-494.

1. If a water reduction of at least 5% is made through the use of an admixture, a cement reduction may be made not to exceed 10% of the required cement content for all classes of concrete. In no case shall the resulting water cement ratio exceed 0.50. Compressive strengths shall be maintained in accordance with the mix requirements.

2. Use of admixtures which contain calcium chloride will not be permitted where concrete is placed against galvanized S-I-P forms, where galvanized or aluminum metals are embedded in concrete, where steam curing is used, or where concrete is to be exposed to sulfate attack.

3. Admixtures and air-entraining agents shall be added to the mix water, each agent introduced separate from the other. Under no circumstances are these agents to be combined prior to their introduction in the mixing unit.

E. WATER - All water used in concrete shall be submitted for the approval of the Engineer and shall be reasonably clear and free from oil, acid or alkali and vegetable substances, and shall not be brackish or salty. Water of doubtful quality shall be tested in briquettes as prescribed by

Montana Test Method MT-109 and the strength of such briquettes shall be equal to similar briquettes made of water of known satisfactory quality.

F. FINE AGGREGATE FOR CONCRETE -

1. General Requirements.

a. Fine aggregate shall consist of natural sand having hard, strong, durable particles conforming to the gradation table in this section. Other approved inert material with similar characteristics, or combinations of the above materials, may be used providing that all such materials meet the requirements of these specifications.

b. Fine aggregate from different sources of supply shall not be mixed or stored in the same pile nor used alternately in the same class of construction or mix, without permission from the Engineer.

c. The requirements for deleterious substances and soundness given in 2 and 3 below will be waived in the case of aggregate for use in structures or portions of structures not exposed to the weather, or provided a satisfactory service record of at least 5 years under similar conditions of service and exposure shall have been demonstrated.

2. Deleterious Substances.

a. The quality of deleterious substances shall be not greater than the following maximum limits.

	Recommended Limits % by Wt.	Maximum Limits % by Wt.
Coal and lightweight pieces	0.25	1.00
Clay lumps	0.50	1.00

b. The material shall be reasonably free from other deleterious substances such as shale, alkali, mica, coated grains, and soft, flaky particles.

3. Soundness. When the fine aggregate is subject to 5 cycles of sodium sulfate soundness test (AASHTO T-104), the total corrected percentage loss shall not exceed 10% by weight.

4. Organic Impurities. Aggregates subjected to the colorimetric test for organic impurities and producing a color darker than the standard (AASHTO T-21, Alternate B) shall be rejected unless they pass the mortar strength test as specified in paragraph 5. Should the aggregate show a darker color than that of samples originally approved for the work, its use shall be withheld until tests satisfactory to the Engineer have been made to determine whether the increased color is indicative of an injurious quantity of deleterious substances.

5. Mortar-Making Properties. When subjected to the test for mortar making properties, the fine aggregate shall develop a compressive strength at the age of 7 days when using Type II cement, of not less than 95% of the strength developed by a mortar prepared with the same cement and in accordance with AASHTO T-71.

6. Grading.

a. The gradation requirements given in (b) below represent the extreme limits which shall determine suitability for use from all sources of supply. The gradation from any one source shall be reasonably uniform and not subject to change from the low to the high gradation limits specified in paragraph (b) below. The fineness modules of representative samples taken from proposed sources shall be determined in accordance with AASHTO M-6 and shall be not less than 2.50 nor more than 3.10. Fine aggregate from a source having a variation in fineness modules of the representative sample submitted may require a redesign of concrete mixes. The application of the 0.20 variation shall not cause the fineness modules to be less than 2.50 or more than 3.10.

b. Fine aggregate shall meet the following gradation requirements when tested by laboratory sieves and shall be graded from coarse to fine within those requirements.

Passing 3/8 inch sieve	100%
Passing 4 mesh sieve	95 - 100%
Passing 8 mesh sieve	65 - 95%
Passing 16 mesh sieve	35 - 80%
Passing 50 mesh sieve	5 - 30%
Passing 100 mesh sieve	0 - 10%
Passing 200 mesh sieve	0 - 3%

G. COARSE AGGREGATE FOR CONCRETE -

1. General Requirements.

a. Coarse aggregate shall consist of crushed stone, gravel or blast-furnace slag having hard, strong, durable pieces reasonably free from adherent coatings. Other approved inert materials with similar characteristics, or combinations of the above materials may be used providing that all materials meet the requirements of these specifications.

b. The requirements for deleterious substance and soundness given in part 2 and 3 below will be waived in the case of aggregate for use in structures or portions of structures not exposed to the weather, or provided a satisfactory service record of at least 5 years under similar conditions of service and exposure shall have been demonstrated.

2. Deleterious Substances.

a. The quantity of deleterious substances shall be no greater than the maximum limits.

	Recommended Limits % by Weight	Maximum Limits % by Weight
Coal and lignite	0.25	1.00
Clay lumps	0.25	0.25
Soft fragments	2.00	5.00
Thin or elongated pieces having a length greater than 5 times average thickness	0.00	15.00
Material passing the No. 200 sieve		1.00

In the case of the crushed aggregates, if the material finer than the No. 200 sieve consists of the dust of fractures essentially free from clay or shale, the maximum limit may be increased to 1.5%.

b. The material shall be reasonably free from other deleterious substances such as shale, alkali, mica, coated particles and soft, flaky particles.

3. Soundness. When the coarse aggregate is subjected to 5 cycles of the sodium sulfate soundness test (AASHTO T-104), the total percentage loss shall not exceed 12% by weight.

4. Percentage of Wear. Coarse aggregate, when tested by the Los Angeles method, AASHTO T-96, shall have a percentage of wear not to exceed 40%.

5. Grading.

a. One and one-half inch aggregate shall conform to the gradation requirements tabulated below for No. 4 to 1 1/2 inches size material and shall be furnished in two separate sizes conforming respectively to the gradation tabulated for No. 4 to 3/4 inc size material and 3/4 to 1 1/2 inches size material.

Three-quarter-inch aggregate shall conform to the gradation requirements tabulated below for No. 4 to 3/4 inch size material.

b. Coarse aggregate shall be uniformly graded between the limits specified. The sizes designated shall meet the requirements of the following table, when tested by means of laboratory screens.

Designated Sizes	Percentage by Weight Passing Laboratory Sieves Having Square Openings							
	2"	1-1/2"	1-1/4"	1"	3/4"	1/2"	3/8"	No.4
No.4 to 3/4"				100	85-95	40-75	20-55	0-10
No.4 to 1-1/2"	100	95-100	70-95		35-70		10-30	0-5
No.3/4 to 1-1/2"	100	90-100	55-90	20-25	0-15			

c. It is the intent of these Specifications that there shall be a portion of the material above the minimum gradation shown in each designated size.

d. The shape of aperture specified in determining compliance with specifications for size of coarse aggregate has no relation to the size and shape of the aperture or type of screen used in the production of the material.

The following test methods will be used to evaluate the quality of aggregates for concrete.

Fineness Modules of Fine Aggregate	AASHTO M-6
Sieve Analysis for Fine and Coarse Aggregate	AASHTO T-11 and T 27
Los Angeles Wear Test	AASHTO T-96
Soundness (Sodium Sulfate)	AASHTO T-104
Mortar Making Properties	AASHTO T-71
Organic Impurities	AASHTO T-113
Coal and Light Particles	AASHTO T-113
Clay Lumps	AASHTO T-112

H. INSERTS, ANCHOR BOLTS, AND ACCESSORIES - All items to be incorporated on or in the concrete work shall be as specified elsewhere. When not specified or called out on the Drawings, such items shall be manufactured or fabricated to perform the function for which they are intended without deleterious effects to the concrete. Expansion anchors and anchor bolts shall be as specified in Subsection 720.00, Structural Steel and Miscellaneous Metal.

I. WATERSTOPS AND EXPANSION MATERIAL -

1. Waterstop. Virgin polyvinyl chloride conforming to CRD-C 572 or rubber conforming to CRD-C 513, as manufactured by Water Seals, Inc., Williams Products, Inc., or equal. Waterstop shall be dumbbell or corrugated type and shall have a hollow center bulb when used in an expansion or contraction joint.

2. Expansion Material. Closed-cell virgin neoprene 1/2 inch thick and of width sufficient to fully penetrate the slab.

J. REINFORCING STEEL -

1. Bar Reinforcement. Reinforcement steel shall be of the deformed type and shall meet the requirements of ASTM A-615, (AASHTO M-31), Grade 60 except for #3 and #4 stirrups or ties which shall be of Grade 40.

Where purchases from warehouse in small lots, reinforcing steel may, at the direction of the Engineer, be accepted subject to the bending test as specified in ASTM A-615 or AASHTO M-31.

The test specimen shall bend cold around a pin without cracking on the outside of the bent portion.

2. Wire and Wire Mesh. Wire shall conform to the specifications for cold-drawn steel wire for concrete reinforcement for AASHTO M-32 (ASTM A-82).

Wire mesh, when used as reinforcement in concrete shall conform to the specification for welded steel wire fabric for concrete reinforcement of the AASHTO M-55 (ASTM A-185). The type of mesh shall be approved by the Engineer.

Bar mats shall conform to the requirements of AASHTO M-54 (ASTM A-184).

710.03 CONSTRUCTION REQUIREMENTS

A. REINFORCING STEEL -

1. Protection of Material. Steel reinforcement shall be protected at all times from injury. When placed in the work, it shall be free from dirt detrimental scale, paint, oil, and other foreign substance. When steel reinforcement has detrimental rust, loose scale, or dust which is easily removable, it shall be cleaned by a satisfactory method, if approved. Steel reinforcement stored at the site shall be stored above the ground surface on platforms, skids, or other supports.

2. Fabrication. All bars shall be bent cold, unless otherwise permitted. No bars partially imbedded in concrete shall be field bent except as shown on the Drawings or otherwise permitted.

Bar reinforcement shall be shipped in standard bundles, tagged and marked in accordance with the "Manual of Standard Practice for Detailing Reinforced Concrete Structures" (ACI 315).

Details of concrete reinforcement and accessories not covered herein or on the drawings shall be in accordance with "Manual of Standard Practice for Detailing Reinforced Concrete Structures" (ACI 315).

3. Placing and Fastening. All steel reinforcement shall be accurately placed in the positions shown on the Drawings and firmly held during the placing and settling of the concrete.

All reinforcement shall be supported and fastened together to prevent displacement by construction loads. On ground, where necessary, supporting concrete blocks may be used. Over formwork, concrete, metal, plastic, or other approved bar chairs and spacers shall be used. Where the concrete surface will be exposed to the weather in the finished structure, the portions of all accessories within 1/2 inch of the concrete surface shall be non-corrosive or protected against corrosion.

Unless otherwise specified on the drawings, splices of reinforcing bars shall provide an overlap equal to at least 30 times the diameter of the smaller bar in the splice but not less than 12 inches.

Welded wire fabric designated as load-carrying reinforcement shall be overlapped wherever successive mats or rolls are continuous in such a way that the overlap measured between outermost cross wires of each fabric sheet is not less than the

spacing of the cross wires plus 2 inches. It shall be supported as required for reinforcing bars.

Welded wire fabric not specifically designated as load-carrying reinforcement shall be overlapped wherever successive mats or rolls are continuous in such a way that the overlap measured between outermost cross wires of each fabric sheet is not less than 2 inches. The fabric shall extend across supporting beams and walls and to within 4 inches of concrete edges. It may extend through contraction joints. It shall be adequately supported during placing of concrete to insure its proper position in the slab either by the methods previously described in this section of by laying the fabric on the layer of the fresh concrete of the correct depth before placing the upper layer of the slab.

Vertical bars in columns shall be offset at least one bar diameter at lapped splices. To insure proper placement, templates shall be furnished for all column dowels.

All splices not shown in the Contract Documents shall be subject to approval. Mechanical connectors for reinforcing bars may be used subject to approval.

The use of pebbles, pieces of broken stone, concrete rubble, broken brick or building blocks, metal pipe, or wooden blocks will not be permitted.

Unless shown otherwise on the Drawings, the minimum concrete protective covering for reinforcement, except for extremely corrosive atmosphere, other severe exposure or fire-protective covering shall be as follows:

Concrete deposited against ground:	3 inches
Formed surfaces exposed to weather or in contact with the ground:	
#6 bars or larger	2 inches
smaller than #6 bars	1 1/2 inches
Interior Surfaces:	
Beams, girders and columns	1 1/2 inches
Slabs, walls and joints:	
# 18 or smaller	3/4 inch
#14 and #18 bars	1 1/2 inches

Reinforcement in any member shall be placed, inspected and approved by the Engineer before the placing of concrete begins. Concrete placed in violation of this provision may be rejected and its removal required.

If fabric reinforcement is shipped in rolls, it shall be straightened into flat sheets before being placed.

4. Welding. When required or approved, welding of reinforcing steel shall conform to "Reinforcing Steel Welding Code" (AWS D12.1). No welding shall be done at the bend in a bar. Welding or crossing bars (tack welding) shall not be permitted except for specific conditions authorized by the Engineer. The ASTM Specifications shall be supplemented by requirements assuring satisfactory weldability by this procedure.

B. SAMPLING, HANDLING, MEASURING AND BATCHING CONCRETE MATERIALS - Concrete of the classes specified shall be made up of acceptable material batched in the proportions specified by the laboratory mix design (Method One) or field test data (Method Two). Corrections necessitated by variations in the moisture content of the component materials or for other similar reasons shall be made based upon laboratory and field determination.

The fine and coarse aggregates will be sampled in accordance with the method described in Montana Test Method MT-201 with sample sizes corresponding to those used in MT-202.

The Contractor may weigh or measure the water. The cement, the fine aggregate, and both sizes of coarse aggregate shall be weighed.

1. Water. The water shall be measured either by volume or weight. The allowable error in accuracy of water measuring or weighing equipment shall be so arranged that the accuracy of the measurement will not be affected by variations in pressure in the water supply lines. An auxiliary tank from which the measuring or weighing tank is filled may be required.

   When water is measured by volume it shall be metered through an approved recording water meter device. Metering devices shall be accurate to within ± 1% of the required volume of ± 1 gallon, whichever is greater. This device is required on all batching and mixing equipment during warm weather operations. Other approved methods of water measurement will be permitted during cold weather operations. Wash water shall be completely discharged prior to performing any batching operation.

2. Cement. Cement may be measured either by weight or by volume. Volume shall mean 94 pound bags as packed by the manufacturer. If the volume method is used, cement in all batches of concrete mixed shall be in full bags. No batch shall be run using fractional bags of cement. When cement is measured by weight it shall be weighed on a separate scale which is accurate and maintained within a maximum tolerance of 1% of the load being weighed.

3. Equipment for Weighing Aggregates. The weighing equipment and weighing methods shall meet the following requirements.

   a. The capacity of the weighing equipment shall be adequate to permit weighing of materials without delaying the production of the mixer. The balance of weighing mechanism shall be of the beam or springless dial type, and shall be so designed and built that it may be maintained within a maximum tolerance of one percent of the load being weighed. The weighing equipment shall be subject to such tests as the Engineer deems necessary to determine its accuracy.

   b. The value of the graduations shown on the scale shall permit the weighing of materials within the accuracy specified. The Engineer will determine acceptability of the graduation value when fractional batches are used.

   c. Scales of the suspended hopper type shall be equipped with a telltale dial or similar device that indicates at least the last 50 pounds of load. The telltale dial or similar device shall be placed in a position that will allow easy observation by the batch operator.

d. The batching plant may include bins, weighing hoppers, and scales for the fine aggregate and for each size of coarse aggregate. A single weighing hopper with an accumulative scale will be permitted provided a separate scale is used for weighing the cement.

e. The batch plant will be acceptable as meeting the requirements of having a separate scale for weighing the cement if:

1. The batch plant scales are maintained within the maximum tolerances that are specified for weighing cement;

2. If the cement is always weighed in a separate inner hopper of conventional design and;

3. If the cement is always batched and weighed first in the batching sequence.

f. Batching plants will be permitted which are equipped to proportion aggregates and bulk cement by automatic weighing devices of an approved type.

g. The Contractor shall provide each field scale installation with 10 standard 50 pound test weights.

4. Truck Mixers and Agitators. Truck mixers shall be a closed, watertight, revolving drum, suitable powered and mounted. The drum shall be fitted with blades capable of thoroughly mixing the concrete and completely discharging it without segregation. The Contractor shall make available copies of the design of the mixer showing dimensions and arrangement of blades. Mixers having blades worn down more than 3/4 inch from the new condition as shown in the design shall not be used until the blades are replaced or repaired. The drum shall be clean and free of hardened concrete.

The mixing speed of the drum shall not be less than 4 or more than 15 revolutions per minute. The agitating speed of the drum shall be not less than 2 or more than 6 revolutions per minute.

Truck mixers shall have the manufacturer's plate attached showing the rates mixing and agitating capacity and the rate drum speed for mixing and agitating.

Truck mixers shall be equipped with a suitable revolution counter, which will register the number of revolutions of the drum. The counter shall be mounted so that it can be easily read by both the operator and Engineer.

Truck mixers shall be equipped with a water-metering device to accurately indicate water added to the batch. Metering devices shall be accurate to within ± 1% of the required volume of ± 1 gallon, whichever is greater. The truck mixer metering device will not be required where all batch water is added at the plant or other location through an approved metering device.

C. CONCRETE CONSISTENCY - Concrete shall be of such consistency that it will flow around reinforcing steel but individual particles of the coarse aggregate when isolated shall show a coating of mortar containing its proportionate quantity of sand. The consistency of concrete will be gauged by the ability of the equipment to properly place the concrete in its final position and

not by the difficulty in mixing or transporting. The quantity of mixing water used shall be the minimum necessary to provide workability within the ranges of slump specified. The quantity of the mixing water shall not be varied without approval.

Concrete shall be mixed in an approved truck mixer meeting the requirements of Subsection 710.03B(4).

The capacity of the plant and the transportation equipment shall be sufficient to ensure delivery at a rate that will permit proper handling, placement, and finishing at the point of delivery. The interval between delivery of loads shall be such that no lift or layer of concrete shall remain exposed for more than 20 minutes before being covered by fresh concrete.

A batch slip indicating the batch components, volume, and time of batching shall be issued to the driver at the plant. The slip shall be delivered to the Engineer by each truck arriving at the site of the work.

Mixing shall commence immediately after introduction of the cement and water, and shall continue for at least 70 revolutions of the drum at mixing speed. Not more than 100 revolutions of the drum shall be at a speed in excess of 6 revolutions per minute. Any other revolutions shall be at agitating speed or not less than 2 or more than 6 revolutions per minute.

The concrete shall be discharged at the job and placed in its final position in the forms within 1 1/2 hours after the introduction of the mixing water and cement. When the air temperature is 85° F or above, the concrete shall be placed in its final position in the forms within 1 hour after the introduction of the mixing water and cement.

E. PLACING CONCRETE - Concrete shall be thoroughly compacted into its final position. It shall be well consolidated around fittings and embedded items. All reinforcement and other embedded items shall be accurately placed as shown on the Drawings and shall be thoroughly clean and substantially free from coatings of dried mortar, detrimental rust, scale, oil, or foreign matter.

Untreated forms and existing concrete shall be kept continuously wet for a period of not less than one hour before any concrete is placed therein. They shall be kept wet until covered with concrete except that adequately treated forms shall be thoroughly washed with a water spray immediately prior to placing the concrete.

F. CURING CONCRETE - Curing shall continue for a period of not less than 7 days after placing the concrete. The surfaces of concrete placed against forms may be cured by leaving the forms securely fastened in place for a minimum of 7 days, when approved.

The curing of concrete, accomplished by either water curing or membrane curing, shall be as follows unless otherwise approved by the Engineer.

1. Water Curing. All top surface concrete shall be kept continuously moist after finishing, with a fine water spray, until the concrete has set. The moist concrete shall then be covered with water or an approved curing covering.

   a. Curing shall be accomplished by placing burlap, cotton mats or other absorptive material as close behind the finishing operation as possible without marring the finished surface. The absorptive material shall be kept continuously moist for the full time it is used. The absorptive material may be kept in place for the entire

curing period or it may be removed as soon as practicable and the entire surface covered with approximately 1 1/2 inches of sand which shall be kept continuously moist for the entire curing period.

b. The removal of forms and the repair of surface irregularities shall be accomplished without interfering with any of the curing requirements. As soon as the vertical forms have been removed and the surface irregularities repaired, the concrete shall be completely covered with absorptive material which shall be kept continuously wet for the balance of the curing period.

2. Impervious Membrane Curing. Membrane curing compounds shall comply with AASHTO M-148 Type 2, white-pigmented for structural deck slabs and Type 1-D, clear with a translucent fugitive dye for other use. It shall be delivered to the job in the manufacturer's original container, clearly labeled to show the name of the manufacturer and the contents. The clear curing compound shall be sufficiently transparent and free from permanent color to result in no pronounced change in color from the natural concrete. The clear compound shall contain a fugitive dye of color strength sufficient to render the film distinctly visible on the concrete for a period of at least 4 hours after application. The concrete surface shall resume its natural color, after curing.

a. The material shall be ready for use as shipped by the manufacturer and no diluting will be permitted. No curing material shall be used without written approval. Sampling will not be necessary if manufacturer's certification is available. The curing compound shall be applied under pressure with a spray nozzle in a manner that will cover the entire exposed surface thoroughly and completely with a uniform film at the rate of not less than one gallon per 150 square feet of concrete surface. Sufficient pressure shall be maintained in the spray machine to force the material to leave the nozzle in the form of a fine mist. All concrete surface shall be kept moist with a fine water spray or with wetted burlap until the sealing compound is applied. The application of the curing compound shall be kept close to the finishers of the top surface of concrete at all times and the concrete shall be sealed immediately after the finishing operations have been completed, to the satisfaction of the Engineer.

b. If it is necessary to allow workmen, wheelbarrows, concrete buggies and the like on the surface before the 7-day curing period is completed, the top surface of sealed concrete shall be covered with a protective cushion for runways. This cushion shall consist of a moist 1 inch minimum thick layer of fine sand or sufficient layers of moist burlap that will prevent abrasive damage to the finished concrete. The approved cushion shall be covered with 4-foot by 8-foot sheets of 3/4 inch plywood laid over the cushion. The cushion material shall not be placed for at least 8 hours after the final application of the curing compound. Any other proposed cushion material shall be approved in writing by the Engineer before use. Layers of plastic, visqueen or canvas are not considered as an acceptable cushion material.

G. SURFACE REPAIR - The Contractor shall remove all surface irregularities, repair all depressions, voids, or holes, including those formed by trapped air, to the satisfaction of the Engineer. Concrete, from which forms have been stripped, shall be kept continuously moist until surface repair and finishing are completed or impervious membrane curing shall be applied until repairs can be made.

H. WEATHER AND NIGHT LIMITATIONS -

1. General. Concreting operations shall be discontinued when darkness prevents good workmanship in placing and finishing operations. Night operations may be conducted upon specific written approval and when an adequate and approved artificial lighting system is provided.

Except by specific written authorization, concreting operations shall not be continued when a descending air temperature in the shade and away from artificial heat falls below 40° F or resumed until an ascending air temperature in the shade and away from artificial heat reaches 35° F. No concrete shall be placed on a frozen foundation course or subgrade.

The Contractor shall assume all risk of placing concrete in cold weather. Placing concrete during cold weather shall in no way relieve the Contractor of the responsibility for proper results.

Before any concrete is placed, all ice, snow, and frost shall be completely removed from within the formwork receiving the concrete. Any concrete injured by frost action shall be removed and placed at no cost to the Owner.

Before cold weather concrete work is permitted to start, the Contractor shall furnish recording thermometers, which will record temperatures from 0° through 100° F automatically and continuously on a chart for periods of not less than 24 hours. During cold weather concreting, recording thermometers shall be furnished to keep accurate records of curing temperatures. One such thermometer shall be provided for at each structure being constructed. The Contractor shall furnish and place sufficient other type thermometers as deemed necessary at the locations designated by the Engineer.

2. Heating and Placing Concrete. When concreting is authorized during cold weather, the aggregates shall be heated by either steam or dry heat prior to being placed in a mixer. Heating equipment shall heat the material uniformly. Such heating shall preclude the occurrence of nonuniform moisture contents, contamination in the aggregates, or overheated areas. The temperature of the mixed concrete shall not be less than 50° F or more than 90° F at the time of placing it in the forms. If the air temperature at the time of placing the concrete is 40° F or less, the aggregates and water shall be heated to not less than 40° F nor more than 150° F. Material containing frost or lumps or frozen material shall not be used. Neither salt nor chemical admixtures shall be added to the concrete to prevent freezing.

3. Protection of Concrete. During the curing period, if the air temperature is anticipated to fall below 32° F, a sufficient supply of dry straw, hay, grass, or other approved blanket-type insulating material shall be provided along the work for covering all concrete that has been in place for 7 days or less. If at any time the ambient temperature drops to 32° F or less, the concrete shall be protected as follows: Between 2 layers of plastic sheeting, the insulating materials, with the exception of commercial blankets, shall be spread loosely to a minimum depth of 6 inches, but in all cases to a sufficient depth to prevent freezing of or frost damage to the concrete. The blanketing material shall be maintained at least until the end of the regular specified curing period, which shall not be less than 7 days. The Engineer may direct that the blanketing material remain for an additional period if the recorded temperatures indicate that additional curing may be necessary. If required by the Engineer, concrete in place less than 24 hours shall be

covered by approved heating enclosures and devices capable of maintaining the surface temperature of the concrete at not less than 50° F.

Combustion heaters shall be blocked up off the surface of the concrete and vented to the outside of the enclosure to avoid surface carbonation. The maximum temperature anywhere within the enclosure shall not exceed 120° F when the concrete is protected by means other than live steam.

At the close of the curing period, the heat may be reduced to such an extent that the temperature inside the housing shall not decrease faster than 15° per hour until such time that the temperature inside the housing is the same as that outside. A sudden change of temperature shall be prevented.

I. TESTING -

1. Standard Slump Tests. The Engineer shall regularly during each day's pour, check the consistency of the concrete by means of a slump test. A slump test shall also be made each time that a test cylinder is made. Slump tests shall be made in accordance with the "Method of Test for the Slump of Portland Cement Concrete", ASTM Designation C-143.

2. Compression Tests. A set of at least 3 standard 6 inches diameter test cylinders shall be made and tested for every concrete pour, and one set of test cylinders shall be made for every 100 yards of concrete or fraction thereof placed in each pour. On a given project, if total volume of concrete is such that frequency of testing required above would provide less than 5 strength tests for a given class of concrete, tests shall be made from at least 5 randomly selected batches or from each batch if fewer than 5 batches are used. These cylinders should be cured under laboratory conditions except that additional test cylinders cured entirely under field conditions may be required by the Engineer to check the adequacy of curing and protection of the concrete. All specimens shall be taken by the Engineer. The Contractor shall transport all specimens to the testing laboratory.

   Samples for strength tests shall be taken in accordance with "Method of Sampling Fresh Concrete" (ASTM C-172).

   Test cylinders shall be made and laboratory-cured in accordance with the standard method of making and curing concrete compression specimens in the field (ASTM C-31). The Contractor shall furnish the cylinder forms, and all other required apparatus for making test specimens. Cylinders shall be tested in accordance with "Method of Test for Compressive Strength of Cylindrical Concrete Specimens" (ASTM C-39) by an independent testing laboratory, as approved by the Engineer, and all charges made for testing cylinders shall be paid for by the Contractor.

   Of each of the three cylinders taken for a pour, one shall be tested for information strength at 7 days and two tested for acceptance strength at 28 days. To conform to the requirements of this specification, average strength of two cylinders from the same sample, tested at 28 days or the specified earlier age, is required for each strength test. Strength level of an individual class of concrete shall be considered satisfactory if both of the following requirements are met:

   a. The average of all sets of three consecutive strength tests equal or exceed the required specified strength.

b. No individual strength test (average of two cylinders) falls below specified strength by more than 500 psi.

Field-cured cylinders shall be cured under field conditions in accordance with Section 7.4 of "Method of Making and Curing Concrete Test Specimens in the Field" (ASTM C-31). Field-cured test cylinders shall be molded at the same time and from the samples as laboratory-cured test cylinders. Procedures for protecting and curing concrete shall be improved when strength of field-cured cylinders at the test age designated for measuring specified strength is less than 85% of that of companion laboratory-cured cylinders. When laboratory-cured cylinder strengths are appreciably higher than the specified strength, field-cured cylinder strengths need not exceed the specified strength by more than 500 psi even though the 85% criterion is not met.

When the laboratory-cured specimens fail to conform to the requirements for strength, the Engineer shall have the right to reject the concrete, change the mix proportions, or both, at the expense of the Contractor. The strengths of any specimens cured on the job are intended to indicate the adequacy of protection and curing of the concrete and may be used to determine when the forms may be striped, shoring removed, or the structure placed in service. When the strengths of the job-cured specimens are below those specified above, the Contractor will be required to improve the procedures for protecting and curing the concrete.

In addition, when concrete fails to conform to the requirements above or when tests of field-cured cylinders indicate deficiencies in protection and curing, the Engineer may order tests on the hardened concrete as described in Section 17.3 of ACI 301-72 or order load tests as outlined in Chapter 20 of the ACI Building Code (ACI 318-77) for that portion of the structure where the questionable concrete has been placed. No additional compensation will be allowed for load tests or coring. In the event the load or core tests indicate that the structure is unsatisfactory, the Contractor shall, at his own expense, make such modifications as required to make the structure sound.

3. Air Content Tests. The Engineer may check the air content by either the "Method of Test for Air Content of Freshly Mixed Concrete by the Pressure Method" (ASTM C-231), "Method of Test for Air Content of Freshly Mixed Concrete by the Volumetric Method" (ASTM C-173) or "Method of Test for Unit Weight, Yield and Air Content (Gravimetric) of Concrete" (ASTM C-138).

J. ANCHOR BOLTS AND IMBEDDED ACCESSORIES - Anchor bolts and embedded accessories shall be mounted a minimum of 3 times the diameter of the bolt or accessory from the nearest edge of the concrete. Cracked concrete resulting from overtightened bolts or adjacent accessories shall be removed and re-poured to at least 12 inches from any cracks.

SECTION 800: SURFACING - AGGREGATE, BASE COURSES, AND PAVEMENT

SUBSECTION 810.00 AGGREGATE BASE COURSE

810.01 GENERAL

A. DESCRIPTION - This work shall consist of furnishing and placing an aggregate base course composed of crushed or uncrushed gravel or stone or other similar materials meeting the grade or maximum size specified in the Proposal or shown on the Drawings and constructed on the roadway in conformance with these Specifications and the Drawings.

B. SUBMITTALS - The following submittals are required in accordance with the Supplementary Conditions:

- Gradation(s) of aggregate materials.
- Standard Proctor, including moisture density curve for aggregate materials.
- Atterberg Limits and Los Angeles Rattler Test for aggregate materials.
- Percentage of aggregate (by weight) having at least one fractured face, for crushed aggregate only.

C. REFERENCE STANDARDS - Standard Proctor Density, where referenced herein, shall refer to AASHTO T-99. Other standards shall be as noted herein.

810.02 MATERIALS

A. GENERAL - The aggregate base material shall meet the applicable requirements of Subsection 830.00, General Requirements for Production, Crushing, and Stockpiling of Aggregates for Surfacing and Asphalt Plant Mixes of the Standard Specifications.

B. SPECIAL REQUIREMENTS - UNCRUSHED BASE COURSE - shall consist of hard, durable particles or fragments of stone, gravel or other similar materials mixed or blended with sand, stone dust, or other similar binding or filler materials produced from approved sources to provide a uniform mixture complying with the requirements of these Specifications as to gradation, soil constants, and capability of being compacted into a dense and well bonded base. All oversize stones, rocks, and boulders occuring in the pit or quarry material shall be screened out or removed and wasted; those of acceptable quality may be crushed and become a part of the base material, provided the blend meets the specified gradations.

That portion of the material retained on the No. 4 sieve shall have a percent of wear of not more than 50 at 500 revolutions as determined by AASHTO T-96 (Los Angeles Rattler Test).

C. SPECIAL REQUIREMENTS - CRUSHED BASE COURSE - shall consist of both fine and coarse fragments of crushed stone or crushed gravel, and/or natural gravel, blended with sand, screenings or other similar approved materials. The completed mixture of aggregates shall be capable of being compacted into a dense and well-bonded base.

The crushed gravel or stone shall consist of hard durable particles or fragments of stone, free from an excess of flat, elongated, soft or disintegrated pieces, dirt, or other objectionable matter, and shall have a percent of wear of not more than 50 at 500 revolutions as determined by AASHTO T-96 (Los Angeles Rattler Test).

The method used in production shall be such that the percentage of fractured particles occurring in the finished product shall be as nearly constant and uniform as practicable.

All material passing the No. 4 mesh sieve produced in the crushing operation shall be incorporated in the base material unless there is an excessive amount which, if included, would not meet the gradation requirements.

D. GRADATION - As determined to AASHTO Methods T-11 and T-27, the material shall, for the grading specified in the Proposal, including any binder or filler which may have been added at the plant or on the roadway, meet the requirements of that grading in the Table of Gradations.

TABLE OF GRADATIONS

PERCENTAGES BY WEIGHT PASSING SQUARE MESH SIEVES

Sieve Passing	Grade 1	Grade 2	Grade 3
2"	100%	—	—
1 1/2"	—	100%	—
1"	50 - 80%	—	100%
No. 4	20 - 50%	25 - 55%	30 - 60%
No. 10	—	—	20 - 50%
No. 200	8 Max.	8 Max.	8 Max.

A tolerance of 5%, by weight, up to the next above specified gradation (2 1/2 inches for 2-inch max.) will be allowed. The produced material passing the maximum screen opening and retained on the No. 4 sieve shall be uniform in its grading between those limits within 5%.

That portion of the fine grade aggregate, passing the No. 200 sieve shall not be greater than two-thirds of that portion passing the 40 sieve.

The liquid limit for that portion of the fine aggregate passing a No. 40 sieve shall not exceed 25 nor shall the plasticity index exceed 6, as determined by AASHTO-89, T-90, and T-91. The sand equivalent shall not be less than 25 as determined by AASHTO T-176.

810.03 CONSTRUCTION REQUIREMENTS

A. GENERAL - Immediately prior to the placing of the base course, the surface of underlying subgrade, sub-base or base course shall be bladed smooth and shaped to the cross section as shown on the Drawings before the base course is placed on the roadway. No base course shall be placed upon wet or muddy subgrade or sub-base course.

The material shall be mixed and placed in horizontal layers of not more than 6 inches thickness except as allowed by the Engineer. The depositing and spreading of the material on the prepared subgrade, or on a completed sub-base or base course layer, shall commence at the point farthest from the point of loading, unless otherwise instructed, and shall progress continuously without breaks. Hauling over the subgrade, or over any sub-base course completed or in the process of construction, will not be permitted at such times and in such manner as to be detrimental to the subgrade, sub-base or base course. Spreading shall be from dump boards, spreader boxes, or moving

vehicles equipped to distribute the material in a uniform layer or in a windrow. When the material is deposited and spread in a uniform layer, it shall be without segregation of size to such loose depth that when compacted, making due allowance for any filler that is to be blended on the road, the layer will have the required thickness. After the base course material has been spread, it shall be thoroughly blade mixed to the full depth of the layer by alternately blading the entire layer to the center and back to the edges of the roadway. When more than one layer is required, the construction procedure described shall apply to each layer. Each layer shall be bladed smooth and thoroughly compacted as hereinafter specified before the succeeding layer is placed.

Binder, when required, may be added at the plant or on the roadway. If added on the roadway, the binder shall be spread uniformly across the roadway over the loosely spread base course layer. It shall then be thoroughly blended and mixed into the surfacing material by approved methods and equipment. Where the depth of the course if 4 inches or less, the binder shall be processed into the entire depth. Where the depth of the course exceeds 4 inches, the binder shall be processed into not less than the upper 4 inches.

Prior to and during the mixing operation water shall be added to the material in such amounts that the entire mass during mixing is wetted to such an extent as to prevent segregation of fine and coarse materials. The sprinkler or other water spreading device shall be of such type as to provide a uniform distribution of the water without producing any noticeable washing effect upon the base materials.

Materials placed shall be compacted to the full width by rolling with approved tamping or power rollers. Any irregularities or depressions that develop under rolling shall be corrected by loosening the material in these places and adding or removing material, as the case may require, until the surface is smooth and uniform. Where the next course will be an asphalt base course, or asphalt surface course, the final rolling on the sub-base course shall be made with an approved self-propelled steel wheeled roller.

Blading and compacting shall be performed alternately as required to maintain a smooth even, uniformly compacted surface until the final inspection. Along drop inlets, manholes, and similar structures and at all places not accessible to the roller, the base course material shall be tamped thoroughly with approved mechanical tampers or hand tampers to obtain a density conforming to the compaction requirements.

B. COMPACTION REQUIREMENTS FOR BASE COURSES - The Contractor shall provide watering and rolling as required to obtain a field density of 95% of Standard Proctor Density. Compaction approval is good for 48 hours only. If additional surfacing courses are required and not put down within 48 hours after approval, reapproval of compaction must be obtained before any surfacing operations begin.

C. SURFACE SMOOTHNESS - The surface of any base course, when finished, shall be such that when tested with a 10 feet template placed on the surface with its center line parallel to the center line of the roadway, the maximum deviation of the surface from the edge of the straight edge shall nowhere exceed 1/2 inch. In addition, the finished grade shall not deviate more than 0.10 foot at any point from the staked elevation, and provided further, the sum of the deviations from two points not more than 30 feet apart shall not exceed 0.10 foot.

Should patching of the base course by necessary in order to meet the above tolerances, it shall be performed using methods and aggregates described herein. Payment for such aggregate used for patching shall be at the unit price bid for the base course material.

SUBSECTION 820.00 CRUSHED TOP SURFACING COURSE

820.01 GENERAL

A. DESCRIPTION - This work shall consist of furnishing and placing one or more aggregate surfacing courses composed of crushed gravel, or stone, or other similar materials meeting the grade or maximum size specified in the Proposal or shown on the Drawings and constructed on the roadway in conformance with these Specifications and the Drawings.

B. SUBMITTALS - The following submittals are required in accordance with the Supplementary Conditions:

- Gradation(s) of aggregate materials.
- Standard Proctor, including moisture density curve for aggregate materials.
- Atterberg Limits and Los Angeles Rattler Test for aggregate materials.
- Percentage of aggregate (by weight) having at least one fractured face.
- Soundness test results.

C. REFERENCE STANDARDS - Standard Proctor Density, where referenced herein, shall refer to AASHTO T-99. Other standards shall be as noted herein.

820.02 MATERIALS

A. GENERAL - The aggregate surfacing material shall meet the applicable requirements of Subsection 830.00, General Requirements for Production, Crushing, and Stockpiling of Aggregates for Surfacing and Asphalt Plant Mixes, of the Standard Specifications.

B. CRUSHED SURFACING MATERIAL - shall consist of both fine and coarse fragments of crushed stone or crushed gravel, and/or natural gravel, and when approved by the Engineer, blended with sand, finely crushed stone, crusher screenings, or other similar materials. The completed mixture of aggregates shall be capable of being compacted into a dense and well-bonded base.

The crushed stone or gravel shall consist of hard durable particles of fragments of stone, free from an excess of flat, elongated, soft or disintegrated pieces, dirt, or other objectionable matter, and shall have a percent of wear of not more than 45 at 500 revolutions as determined by AASHTO T-96 (Los Angeles Rattler Test).

The method used in production shall be such that the percentage of fractured particles occurring in the finished product shall be as nearly constant and uniform as practicable. The crushing shall result in a product that at least 50% of the material retained on a No. 4 mesh sieve will have at least one fractured face. If necessary to meet this requirement or to eliminate an excess of fine, uncrushed particles, gravel shall be screened before crushing.

Coarse and fine aggregates shall be tested for soundness in accordance with AASHTO T-104. The number of cycles shall be 5, the solution shall be sodium sulphate, and the maximum loss shall not exceed 12%.

All material passing the No. 4 sieve produced in the crushing operation shall be incorporated in the base material unless there is an excessive amount which, if included, would not meet the gradation requirements.

GRADATION - As determined by "Montana Test Method MT-202", the material shall, for the grading specified in the Proposal, including any binder or filler which may have been added at the plant or on the roadway, meet the requirements of that grading in the Table of Gradations:

TABLE OF GRADATIONS

PERCENTAGE BY WEIGHT PASSING SQUARE MESH SIEVES					
Sieve Size	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5
1"	100				
3/4"	—	100			
5/8"	—	—	100		
1/2"	—	—	—	100	
3/8"	—	—	—	—	100
No. 4	40 - 70	40 - 70	40 - 70	40 - 70	50 - 80
No. 10	25 - 55	25 - 55	25 - 55	25 - 60	35 - 70
No. 200	2 - 10	2 - 10	2 - 10	2 - 10	2 - 10

1. Dust Ratio. The portion passing the No 200 sieve shall not be greater than 2/3 of the portion passing the No. 40 sieve.

2. The liquid limit for that portion of the fine aggregate passing a No. 40 sieve shall not exceed 25 nor shall the plasticity index exceed 6, as determined by AASHTO T-89, T-90, and T-91.

3. The composite aggregate shall be free from adherent films of clay or other matter that will prevent thorough coating with bituminous material. It shall be of such nature that the coating of bituminous material will not slough off upon contact with water.

4. Unless otherwise specified, when the aggregate is to be bituminized, both the material source and the composite aggregate shall not have a swell of more than 10% in 8 days and shall show no cracking or disintegration when tested for volume swell and water absorption by Montana Test Method MT-305.

5. No intermediate sizes for cover aggregate or for other purposes shall be removed from the material in the course of production, unless authorized in writing.

820.03 CONSTRUCTION REQUIREMENTS

A. GENERAL - Immediately prior to the placing of the top surfacing course, the surface of underlying subgrade, sub-base or base course shall be bladed smooth and shaped to the cross section as shown on the Drawings before the top surfacing course is placed on the roadway. No top surfacing course shall be placed upon wet or muddy subgrade or sub-base course.

The material shall be mixed and placed in horizontal layers of not more than 6 inches loose thickness except as allowed by the Engineer. The depositing and spreading of the material on the prepared subgrade, or on a completed sub-base or base course layer, shall commence at

the point farthest from the point of loading, unless otherwise instructed, and shall progress continuously without breaks. Hauling over the subgrade or over any sub-base or base course completed or in the process of construction, will not be permitted at such times and in such manner as to be detrimental to the subgrade, sub-base, or base course. The material shall be deposited and spread in a uniform layer without segregation of size to such loose depth that when compacted, making due allowance for any filler that is to be blended on the road, the layer will have the required thickness. Spreading shall be from dump boards, spreader boxes, or moving vehicles equipped to distribute the material in a uniform layer, or the material may be deposited in windrows mixed and spread as described below. When more than one layer is required, the construction procedure described shall apply to each layer. Each layer shall be bladed smooth and thoroughly compacted as hereinafter specified before the succeeding layer is placed.

Binder, when required, may be added at the plant or on the roadway. If added on the roadway, the binder shall be spread uniformly across the roadway over the loosely spread surfacing course layer in the amounts determined by the Engineer. It shall then be thoroughly blended and mixed into the surfacing material by approved methods and equipment. Where the depth of the course is 4 inches or less, the binder shall be processed into the entire depth. Where the depth of the course exceeds 4 inches, the binder shall be processed into not less than the upper 4 inches.

If when the above methods are used and improper segregation, moisture, or compaction exists, or if the material was deposited on the road in windrows, it shall be thoroughly blade mixed to the full depth of the layer by alternately blading the entire layer to the center and back to the edges of the roadway.

Prior to and during the mixing operations water shall be added to the material in such amounts that the entire mass during mixing is wetted to such an extent as to prevent segregation of fine and coarse materials. The sprinkler or other water spreading device shall be of such type as to provide a uniform distribution of the water without producing any noticeable washing effect upon the surfacing material.

Material placed shall be compacted to the full width by rolling with approved tamping or power rollers. Any irregularities or depressions that develop under rolling shall be corrected by loosening the material in these places and adding or removing material, as the case may require, until the surface is smooth and uniform. Where the next course will be an asphalt base course, or asphalt surface course, the final rolling on the sub-base course shall be made with an approved self-propelled steel wheeled roller.

Blading and compacting shall be performed alternately as required to maintain a smooth, even, uniformly compacted surface until the final inspection. Along drop inlets, manholes, and similar structures and at all places not accessible to the roller, the surfacing course material shall be tamped thoroughly with approved mechanical tampers or hand tampers to obtain a density conforming to the compaction requirements.

B. COMPACTION REQUIREMENTS FOR TOP SURFACING COURSES - The Contractor shall provide watering and rolling as required to obtain a field density of 95% of Standard Proctor Density. Compaction approval is good for 48 hours only. If asphalt surfacing is required and not put down within 48 hours after approval, reapproval of compaction must be obtained before any surfacing operations begin.

C. SURFACE SMOOTHNESS - The surface of any top surfacing course, when finished, shall be such that when tested with a 10-foot template placed on the surface with its center line parallel to the center line of the roadway, the maximum deviation of the surface from the edge of the straight edge shall no where exceed 3/8 inch. In addition, the finished grade shall not deviate more than 0.05 foot at any point from the staked elevation, and provided further, the sum of the deviations from two points not more than 30 feet apart shall not exceed 0.05 foot.

If asphalt concrete surfacing is to be placed on the aggregate surfacing course, no portion of the completed surface of a top surfacing course shall be more than 1/4 inch below the edge of template 10 feet in length laid parallel to the center line of the roadway. In addition, the finished grade shall not deviate more than 0.02 foot at any point from the staked elevations and provided further, the sum of the deviations from two points not more than 30 feet apart shall not exceed 0.02 foot.

Should patching of the surfacing course be necessary in order to meet such tolerances, it shall be performed using methods and aggregates described herein. Payment for such aggregate used for patching shall be at the unit price bid for the top surfacing course material.